THE ENGINEER.

Electric Transport.

ELECTRIC TRANSPORT.

INTRODUCTORY.

IN entering upon a subject so broad as electric transport it is scarcely necessary to say that limitation of space makes it impossible to go deeply into detail, for it must be obvious that in view of all that has been done in the way of electrifying railways and tramways and in the application of electricity to other systems of locomotion anything beyond giving a general survey of the subject in a Supplement of this description is out of the question. Moreover, with a few exceptions, we shall only consider work that has been carried out in the United Kingdom, notwithstanding all the great things that have been accomplished in America and on the Continent. First of all, however, we shall deal with early experiments, and endeavour to trace the various steps in connection with the development of electric transport.

There is evidence to show that up to the year 1909 the early history relating to the use of electricity on railways was somewhat neglected, for when Dr. Kapp delivered a series of discourses on "The Electrification of Railways" before the Royal Institution in 1908 he said that in commencing to prepare his lectures he did what most engineers do, namely, looked in the "Encyclopædia Britannica" in the hope of finding a comprehensive article which might be utilised. In this, however, he was disappointed, for only one case of electric propulsion on a railway was mentioned, and it was without details. The information was merely to the effect that in 1842 a certain R. Davidson had constructed an electric locomotive which weighed five tons and was run at a speed of four miles per hour over the Edinburgh and Glasgow Railway. At the annual dinner of the Glasgow Local Section of Electrical Engineers, held in 1909, Mr. W. M. Mordey, the president, drew attention to the fact that Glasgow had the honour of being the very first place in the whole world to give a practical demonstration of electric traction. It was recorded that in 1837 a Robert Davidson propelled a car on the Edinburgh and Glasgow Railway by means of an electric magnetic engine, the current being supplied by a primary battery. It is to be noted that this was five years before the railway was opened. Mr. Mordey suggested that the local section committee might try and find some record of the experimental apparatus used in that prehistoric trial. Acting on this suggestion, Mr. Lackie, the chief engineer of the Glasgow Electricity Department, instituted inquiries in various directions, and ultimately collected quite an appreciable amount of interesting information, which he embodied in a paper on "Early Experiments in Electric Traction," read before the Glasgow Local Section of Electrical Engineers on February 9th, 1909.

From Mr. Lackie's paper and from some additional notes which the author has kindly placed at our disposal, it seems that Robert Davidson was an Aberdeen man, but he evidently spent a great deal of his life in Edinburgh, for he was a member of the Society of Arts there, and lived at Ravelrigg, Midlothian. Prior to Davidson's demonstration, however, in November, 1832, Salvator Del Negro, Professor of Natural Philosophy in the University of Padua, and in December of the same year Dr. Schulthess, of Zürich, both published papers on the subject of "whether such a power as that which is obtained by interrupting the electric current, and then restoring it, could be applied to mechanical science." It also seems that in January, 1833, a machine was exhibited showing how this had been accomplished. In November, 1834, Professor Jacobi, of St. Petersburg, read a note upon a new electro-magnetic apparatus, and at about this date he propelled a boat on the Neva by means of this device. Professor Jacobi continued his investigations in 1838, under the auspices, and at the expense, of an Imperial Commission. He then tried the experiment of impelling a boat on a larger scale, the type of motor used for which is shown in Fig. 8.

The vessel was a ten-oared shallop equipped with paddle-wheels, to which rotary motion was communicated by the motor, which was worked by a battery composed of 64 pairs of platinum plates, each having 36 square metres of surface and charged, according to the plan of Grove, with nitric and sulphuric acid. The boat, with a party of twelve or fourteen passengers on board, went against the stream at the rate of three miles per hour.

In 1839 Professor Jacobi communicated the results of further experiments in ship propulsion to Dr. Faraday in London, and these he in turn communicated to the *London Philosophical Journal*. This communication was the means of Professor Forbes, of Aberdeen, writing to Dr. Faraday giving him a detailed account of the progress made by his fellow-townsman, Mr. Robert Davidson. Mr. Davidson had in operation, and had exhibited in Edinburgh in 1839, a saw mill, a turning lathe, a printing press, and a locomotive engine all worked by electromotive power.

In 1836 a Mr. Davenport, then a blacksmith in Philadelphia, had turning lathes actuated by this power, and in his determination to go ahead, he commenced in 1840 a newspaper, entitled the *Electro-magnetic and Mechanics' Intelligencer*. This paper was published in New York, and was printed on a press worked by an electro-magnetic engine.

It appears that the year 1837, given by Mr. Mordey as being the period in which Mr. Davidson made the trial run on the Edinburgh and Glasgow Railway, is incorrect, for Mr. Lackie's investigations go to show that Mr. Davidson had been engaged in the construction of his first locomotive carriage from 1837, and that this was not finished until two years later. The expense of his experiments, until 1840, were entirely defrayed by himself, but at this date the Royal Scottish Society of Arts voted him a few pounds to be employed in determining certain points connected with electro-magnetic machines, and several gentlemen undertook to defray the expense which might be incurred in the construction of a railway carriage capable of being propelled by the agency of electro-magnetism. This gave rise to the large and massive carriage shown in Fig. 4, which in 1842 was tried on the Edinburgh and Glasgow Railway, now part of the North British system. Thus the date given by "The Encyclopædia Britannica" appears to be correct.

In referring to this trial run the *Railway Times* for December 10th, 1842, says:—"A trial was made last month on the Edinburgh and Glasgow Railway, in the presence of a large number of gentlemen, many of whom are eminent for their scientific knowledge, of this very ingenious machine constructed by Mr. Davidson. The carriage was impelled along the railway about a mile and

Fig. 1—SIEMENS ELECTRIC TRAIN, 1879

Fig. 2—THE OPENING OF VOLK'S RAILWAY AT BRIGHTON, 1883

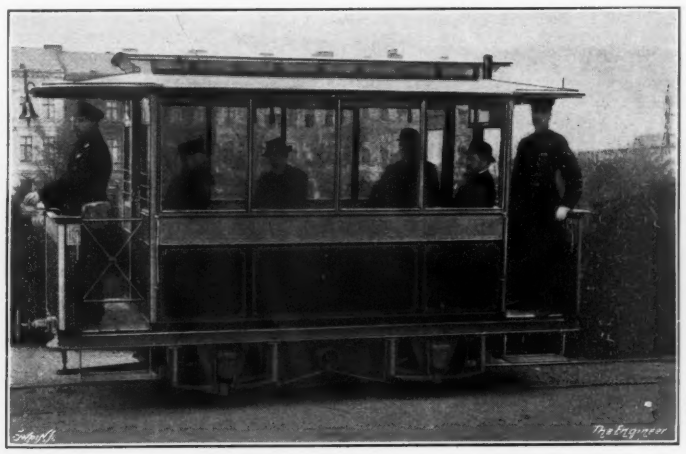

Fig. 3—SIEMENS ELECTRIC CAR AT LICHTERFELDE, 1881

a-half, and travelled at the rate of upwards of four miles an hour—a rate which might be increased by giving greater power to the batteries and enlarging the diameter of the wheels. We understand that the carriage was built at the expense of the railway company, and we cannot but congratulate them on having the discernment to employ Mr. Davidson, a gentleman of much practical knowledge and talent, by whose genius great discoveries have been made in electro-magnetism, by whom the carriage was projected, and to whose unwearied exertions

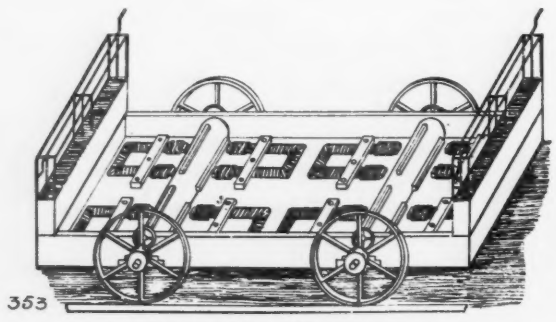

Fig. 4—DAVIDSON'S ELECTRIC CAR, 1842

we owe it that the practicability of the scheme is almost placed beyond doubt. The dimensions of the car are 16ft. long by 7ft. wide, and it is propelled by eight powerful electro-magnets. Including batteries, magnets, &c., the whole apparatus weighed a little over five tons. The carriage was supported by four wheels of 3ft. diameter. On each of the two axles there is a wooden cylinder, on

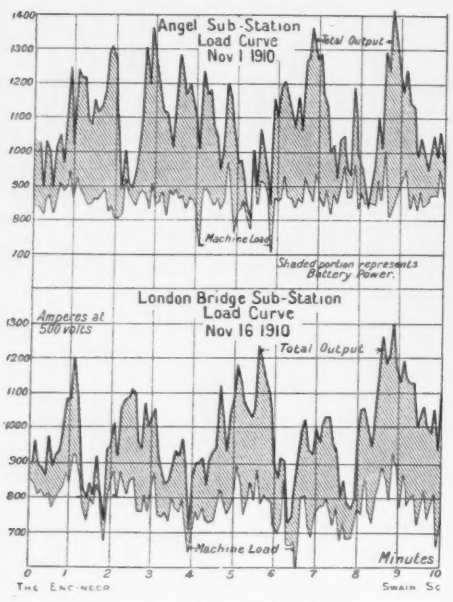

Fig. 5—BATTERY CURVES

which are fastened three bars of iron at equal distances from each other, and resting on the carriage there are eight powerful electro-magnets. When the first bar on the cylinder has passed the faces of two of these magnets, the current of galvanism is then let on to the other two magnets. They immediately pull the second bar until it comes opposite to them. The current is then cut off from these two magnets, and is let on to the other two. Again they pull the third bar until it comes opposite, and so on, the current of galvanism being always cut off from one pair of magnets when it is let on to the other pair." The method of making and breaking the circuit is described at some length, but this only amounts to the description of what we now know as a simple commutator or current interrupter. Continuing, the *Railway Times* says:—At the other end of the carriage there are four magnets and a wooden cylinder, with iron bars arranged in the same manner. The battery which is used for propelling the machine is composed of forty cells of iron and zinc plates, immersed in dilute sulphuric acid, the iron plates being fluted so as to expose greater surface in the same space. The weight propelled was about six tons." According to Mr. Lackie's paper the locomotive made several trips upon Scottish railways, but was finally wrecked by jealous railway employés while it was lying in a car shed at Perth.

The *Practical Mechanic and Engineer's Magazine* for November, 1842, contained a paper by Mr. David Mackie, lecturer on Mechanical Philosophy, entitled "The Prospects of Electro-magnetism as a Prime Mover, with a Note on Mr. Davidson's Apparatus." The opening paragraphs are interesting, for they show that the claims made by this early advocate of electric traction were somewhat different to the claims made now. Mr. Mackie says:—"The dangers to which persons are exposed from the explosions of boilers while travelling by vehicles propelled by steam, though now comparatively rare, still occur to such a degree as to render desirable the adoption of any other means of transit unobjectional on that point, and which at the same time holds out the prospect of being equally economical and effective. To many the power derived from electro-magnetism may appear totally unworthy of consideration when they compare what has hitherto been done with the stupendous effects produced by the agency of steam. Even one hundred years ago no person would have believed that there slumbered in a few gallons of water a power equal to that of hundreds of horses, and which when applied to machinery would, in defiance of wind and tide, impel the largest vessels to the most remote corner of the globe, raise thousands of times its own weight from the bowels of the earth, and propel trains of carriages with a speed which the fleetest coursers cannot equal." The last paragraph of Mr. Mackie's paper is also interesting; it runs as follows:—

"Iron vessels have now been proved well adapted for duty at sea, and since that metal and salt water constitute two important elements of a voltaic battery, may some means not be suggested of introducing the third element, so that a great part, if not the whole, of the surface of the ship may be called into action for the purpose of furthering her progress, thus making the ocean so far her propeller as well as her support. Much less weight would also require to be carried by an electro-magnetic boat than by a steam, and she could therefore undertake much longer voyages."

It is, of course, obvious that no hope of success could be entertained so long as primary batteries were relied on for the propelling power, and it is not surprising that many years elapsed before we hear of anything approaching a successful electrical vehicle being put into operation. Faraday's discovery of magneto-electric induction was made in 1831, but it was not until the years 1865 to 1867 that the era of commercial dynamo design was entered upon. In 1870 Gramme invented his well-known ring armature, and from then onwards the art of dynamo design has made rapid strides. The first electric railway with current supplied to the motor from an insulated rail was unquestionably that shown at an exhibition in Berlin in 1879 by Werner von Siemens. The locomotive and carriages used on this railway are illustrated in Fig. 1. The locomotive was of very simple construction, for a three horse-power motor was mounted on a truck and connected by spur wheels with the axles. It will be gathered from the illustration that the locomotive was coupled to three carriages. The speed was four miles

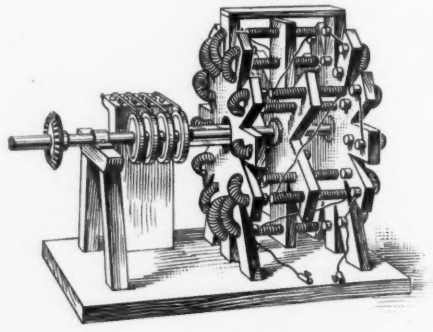

Fig. 8—JACOBI'S MOTOR, 1838

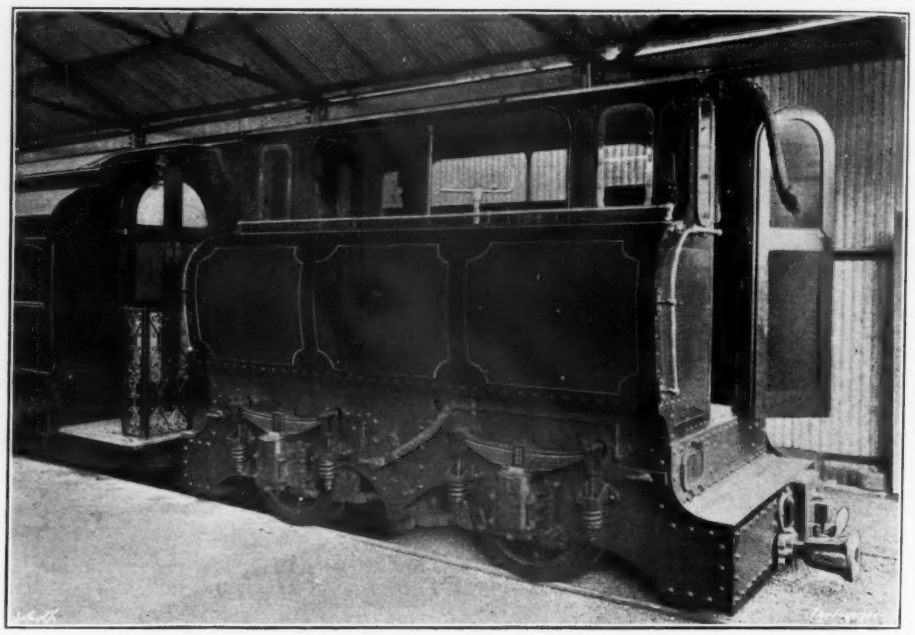

Fig. 7—CITY AND SOUTH LONDON LOCOMOTIVE

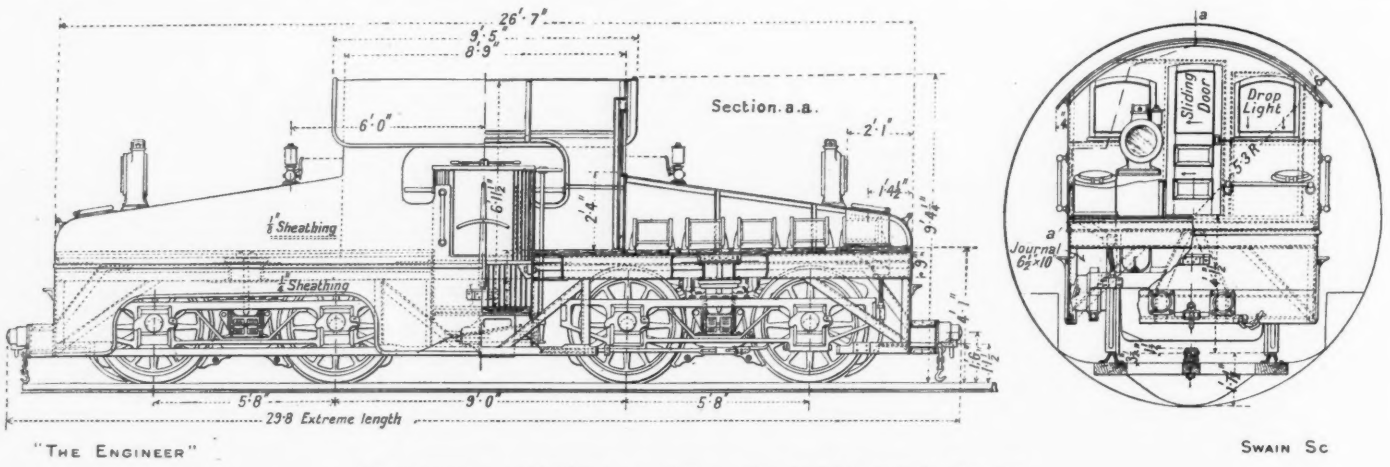

Fig. 6—ORIGINAL LOCOMOTIVE AS USED ON THE CENTRAL LONDON RAILWAY

per hour, the working pressure 150 volts, and the current was conveyed to the motor through a third rail in the centre of the track. In accordance with the practice now commonly adopted, the current was conveyed back to the dynamo through the track trails. It appears, however, that Werner von Siemens abandoned this system in his next application of electricity to the

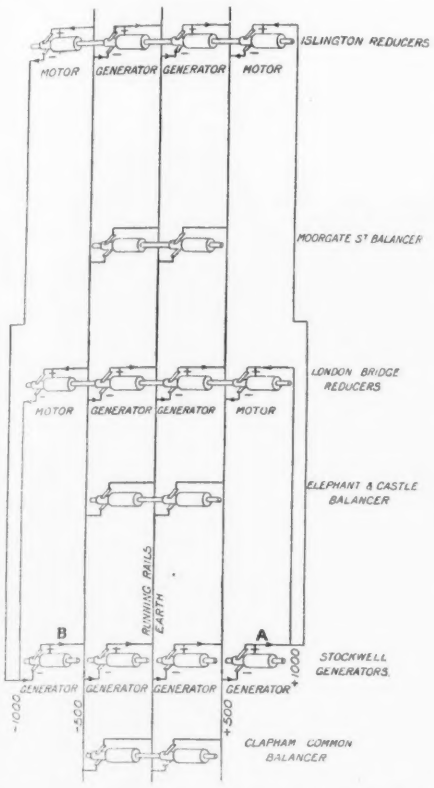

Fig. 9—DIAGRAM OF CITY AND SOUTH LONDON SYSTEM

propulsion of a vehicle on rails, and used the track rails both as lead and return conductors. This was in the electric tramway shown in Fig. 3, which was put down at Lichterfelde, near Berlin, and joined the railway station with the Military Academy. The pressure adopted in this instance was 180 volts, and the maximum speed attained was 22 miles per hour. The gauge was 1 m., and the weight of the car with its full complement of twenty-six

1899. The line is now known as the Giant's Causeway and Portrush Electric Tramway, and is worked on the overhead system. At the "Salmon Leap," about half a mile above Bushmills, the river Bush discharges over the rocks from a height of nearly 30ft. Here a hydro-electric power station has been erected, which supplies current to the line. Mr. Volks' beach railway at Brighton was opened by the Mayor of Brighton on August 2nd of the same year, and was the first electric line put into operation in England. The

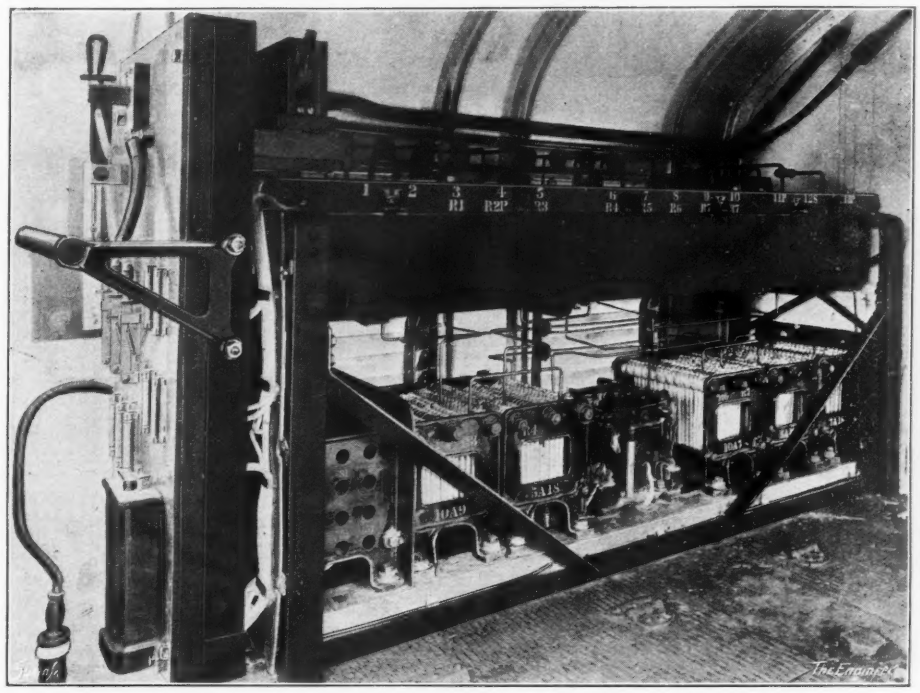

Fig. 11—MOTORMAN'S COMPARTMENT

illustration Fig. 2 is from a photograph taken at the time of the opening ceremony. Originally the line was under a quarter of a mile long, and commenced at the Aquarium entrance and ended at the chain pier. The great success of this short line—30,000 passengers having used it in five months—induced the proprietor, Mr. Magnus Volk, to apply for permission to extend it as far as Paston Place, Kemp Town—a total distance of about

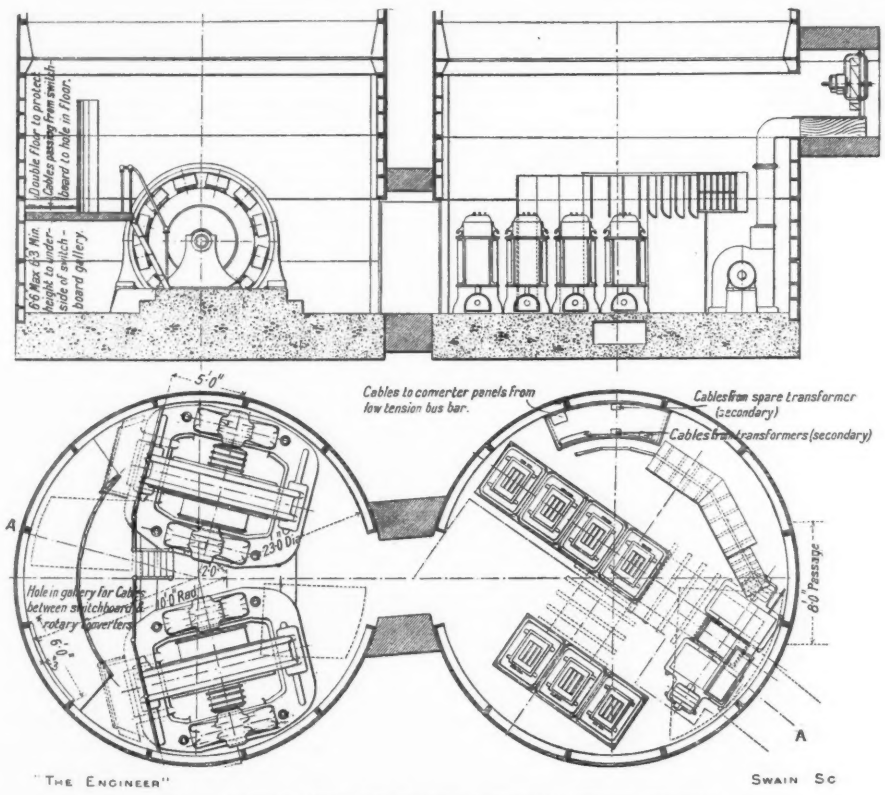
Double floor to protect Cables passing from switchboard to hole in floor.
6'6" Max 5'3" Min Height to underside of switchboard gallery.
5'0"
Cables to converter panels from low tension bus bar.
Cables from spare transformer (secondary)
Cables from transformers (secondary)
A
23'0 Dia
20'
10'0 Radius
Hole in gallery for Cables between switchboard & rotary converters
6'0" Passage
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Fig. 10—MARBLE ARCH SUB-STATION, CENTRAL LONDON RAILWAY

persons 48 tons. Shortly after this line was put into operation, the well-known Portrush and Bushmills Electric Railway was opened in Ireland. This was in 1883, and in the same year Volk's beach electric railway was put into operation at Brighton. An abstract of a paper by the late Dr. John Hopkinson on the "Bushmills Line" is to be found in THE ENGINEER for April 13th, 1883, and an illustrated description is given in THE ENGINEER for September 8th,

one mile. Permission having been granted, the work was duly carried out, and again Mr. Volk's venture proved successful, for we are told that, with a few exceptions, the traffic receipts have increased each year, and at the present time the railway carries about 900,000 passengers per annum. There are now 1½ route miles of track. The rolling stock consists of eight cars, two of which are over twenty-five years old, and it is worthy of mention that Mr. Volk informs us that the Siemens

equipment of these two cars is as good as ever. It is interesting to note that when this railway was first put into operation the running rails were used as the outgoing and return conductors, in accordance with the scheme adopted by Werner von Siemens in his second electric line at Lichterfelde. It seems, however, that the scheme proved unsuccessful, for after the first year or so this practice was abandoned, and the method of collecting the current from a third rail conductor was adopted. The line was originally worked from a gas-driven plant, but at the present time current is taken from the Brighton Corporation mains at a pressure of 460 volts. This pressure, however, is reduced by means of motor generators, so that there are only 170 volts on the track.

From the year 1883 there has been a steady development of electric transport, but with the space at disposal it is obviously impossible to sketch the history of this development in detail. As stated at the outset, it is not our intention to enter into the work done by continental and American engineers, but before we consider more recent developments in the United Kingdom we may draw attention to one landmark in history, namely, the work done by a group of men who formed a committee for the study of high-speed electric railways. This resulted in the famous Zossen trials, which were made in Germany with cars

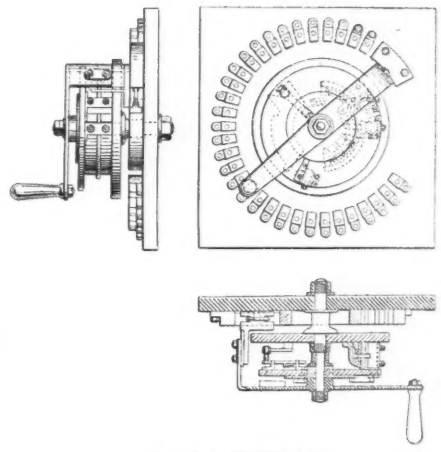


Fig. 12—CONTROLLER

and locomotives built by rival firms. With an expenditure of 1000 horse-power a Siemens three-phase 10,000-volt car attained a speed of 130 miles per hour. There is not the least doubt that the Zossen trials provided a vast amount of useful information, not only in proving that high-speed electric traction was possible with the particular arrangement chosen, but in giving data on which to calculate the power required at high speeds.

Here we must pass on to the most important railways which have been electrified in the United Kingdom, and the first which claims attention is the City and South London Railway. It should be mentioned, however, that up to the time of the opening of this line the only electric railways in England were those at Brighton Beach, Ryde, Isle of Wight, and Southend Pier.

RAILWAYS AND TRAMWAYS.

The City and South London Railway was opened on December 18th, 1890, and has the distinction of being the

first deep-level electric railway in the world. Originally it had terminal stations at Stockwell and King William-street, City, the total length of the line being 3½ miles. In those days the power-house at Stockwell contained three vertical compound engines, driving Edison-Hopkinson dynamos through the medium of belts. A fourth engine and generator were added shortly after the opening, and later a high-speed Willans set was put down, which was the first direct-coupled engine and generator to be used for traction purposes in the United Kingdom. Extensions were opened to Moorgate-street in February, 1900, to Clapham Common on June 3rd, 1900, and to Islington November 17th, 1901. This brought the total length of the line up to over six miles, all double tunnel, whilst the Euston extension, which was opened on May 11th, 1907, added another 1½ miles. When the first-mentioned extensions were considered, and the question of providing additional plant arose, it was decided to build a new generating station, and to convert the old one into a repair shop. The line possesses many interesting features, and an inspection of some of the early appliances used in connection with it proves decidedly entertaining. Originally it was worked on a simple two-wire system, but when the extensions were carried out, and the new generating plant ordered, a conversion was made to the three-wire system, and it is in this connection that the railway differs from practically all others in existence.

The diagram—Fig. 9—shows the system in its simplest form. The up and down working conductors with the running rails as a middle wire form the three-wire system, 500-volt generators being connected across the outers. There are two sub-stations—one at London Bridge and the other at Islington. To supply the sub-stations another generator, either steam or motor-driven, adds an additional 500 volts to a separate set of high-tension bus bars, as shown at A and B, from which the two sub-stations are fed at 1000 volts above the rail potential, corresponding to 2000 volts across the outers. The pressure is lowered at the sub-stations by reducing transformers in which only half the energy is transformed and the cable drop compensated. To simplify the diagram, the reducers at the sub stations are shown as having four armatures, but as a matter of fact each has two double-wound armatures. Those who travelled on this railway in the early days will remember that the steadiness of the light in the carriages was far from perfect, and we are informed that this was mainly due to the bad governing of the engines, and to the drop in the cables, and the small working rail conductor.

When designing the new plant much attention was paid to the question of good voltage regulation, and very close governing of the engines was insisted upon. The first feeding point chosen was Stockwell, where the power-house is situated, and where the drop between the working conductor and the switchboard is practically nil. The next feeding point is Kennington, 1.31 miles from Stockwell. A booster is employed in connection with this feeder, to compensate the drop, but this is only used when the load is heavy, or when it is desirable to reduce the load on the London Bridge sub-station. This sub-station, which is 2.77 miles from Stockwell, forms the third feeding point, and the Angel sub-station, 5.12 miles from Stockwell, is the fourth. It will be seen from the diagram—Fig. 9—that balancers are shown at the Elephant and Castle and at Moorgate-street, but experience has shown that a good voltage balance can be maintained on the two sides of the system without the aid of these machines.

Fig. 13—MOTOR COACH, CENTRAL LONDON RAILWAY

The equipment at the London Bridge sub-station consists of four motor generators. These machines, which perform the double purpose of reducers and balancers, are connected in pairs, one set working on the up and the other on the down side of the system. A battery and booster are also used in this sub-station. The Angel sub-station is also similar to that described, a Highfield booster and battery taking care of the peak loads. The curves shown in Fig. 5 give a good idea of how well these batteries and boosters fulfil their purpose.

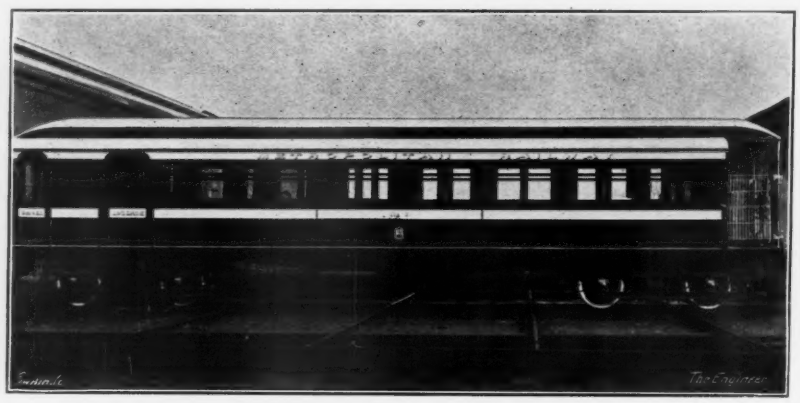


Fig. 14—TRAILER COACH ON METROPOLITAN RAILWAY

This is one of the few electric railways working with locomotives. The type of locomotive employed is shown in Fig. 7. The gauge is 4ft. 8½in. Each locomotive has two motors, the armatures of which are fixed directly on the axles. At first the motors were controlled by simple resistance switches, but series parallel control has now been in use for a number of years. The type of controller employed is that shown in Fig. 12, but recently some of the locomotives have been fitted with drum controllers supplied by the British Thomson-Houston Company. A very complete description of the scheme will be found in a paper read before the Institution of Electrical Engineers in December, 1903, by the company's chief engineer, Mr. P. V. McMahon.

The next electric line in London was the Waterloo and City Railway, which was opened in 1898. Prior to this, however, the Liverpool Overhead Railway was opened in 1893, and the Snaefell Mountain Railway in 1894, but we shall consider the London lines first. The Waterloo and City line, which is now amalgamated with the London and South-Western Railway, runs from the Mansion House to Waterloo, a distance of 1 mile 46 chains. Siemens Brothers supplied the electrical equipment. The gauge is 4ft. 8½in. In view of the short length of this railway it is scarcely necessary to remark that there are no sub-stations. The generating station, which is situated at Waterloo, contains six Belliss engines, which are coupled to two-pole dynamos, the total capacity of the station being 1350 kilowatts. Current is supplied to the car motors by means of a third rail. The standard trains consist of four carriages, each carried by two four-wheeled bogies. One bogie of each of the two end carriages carries two motors, so that a complete train is driven by four motors. The armature of each motor is mounted directly on the axle it drives, thus there is no gearing. The pressure on the track is 500 volts.

The Central London Railway was opened in 1900, and it was the first railway in the United Kingdom to use polyphase transmission. The engines in the power station at Shepherd's Bush, constructed by the E. P. Allis Company, of Milwaukee, are coupled to three-phase generators working at a pressure of 5000 volts and a periodicity of 25 cycles per second. The railway, which was originally known as the Twopenny Tube, runs from the Bank to Wood-lane, Shepherd's Bush. There are sub stations at the Post-office, Marble Arch, Bond-street, and Notting Hill, stations where the alternating current is converted into direct current by means of rotary converters. A somewhat extraordinary feature of this line is the situation of the

Fig. 15—EARL'S COURT SUB-STATION

sub-stations, these being placed in pits formed by extensions of the lift shafts. A drawing showing the general arrangement of the Marble Arch sub-station is given in Fig. 10. It will be gathered that the lower part of one lift shaft contains two rotary converters, and that of the other shaft contains the static transformers and high-tension switch gear. The static transformers reduce the three-phase pressure from 5000 volts to 330 volts. Three-phase current at this pressure is supplied to the rotary converter slip rings, and continuous current at a pressure of 550 volts is supplied from the commutator ends of the machines to the line. The sub-station at Bond-street is the only one on the street level. It is intended chiefly as a stand-by station for the lift and lighting supply, but it also supplies current to the rails and asssts the other sub-stations. The British Thomson-Houston Company, of Rugby, were the contractors for the entire electrical plant for the generating station, sub-stations, and the equipment on the trains. One of the original locomotives as used on this railway is shown in Fig. 6. It will perhaps be remembered that towards the end of 1900 complaints were made as to the vibration caused by the railway. This was generally attributed to the locomotives, and the company decided to experiment with geared motors. For this purpose three of the locomotives were provided with trucks carrying geared motors, and two trains were also equipped on the "train control" system with motors on the front and rear axles of the train, and it is well known that this latter system has now been adopted. One of the motor carriages as used on this line is shown in Fig. 13, and a view of the motorman's compartment is given in Fig. 11.

Following the Central London Railway comes the Great Northern and City Line, which was opened early in 1904. The Act authorising this railway was passed in 1892, Sir Douglas Fox and Partners, together with the late J. H. Greathead being the engineers. The contract for the entire work was taken over by S. Pearson and Son, with the British Thomson-Houston Company as sub-contractors for the electrical equipment for the power-house, line and rolling stock. The power for operating this system is supplied from a generating station situated at Poole-street, New North Road, which is a little over a mile north of Moorgate-street Station. From the power station the current is fed direct to the conductor rails, the length of line and the position of the generating station being such as to enable the system to be operated economically without feeding at any other points, whilst at the same time using a collector rail of convenient section. At present the line is 3½ miles long, and runs from the Great Northern Railway at Finsbury Park to Moorgate-street, but extensions are being carried out to the Bank. The main generating station contains four vertical cross-compound engines constructed by John Musgrave and Sons, of Bolton, driving standard railway generators constructed by the British Thomson-Houston Company, each generator having a capacity of 800 kilowatts. The trains consist of three motor cars and four trailer cars, one motor car being at each end of the train and one in the centre. The pressure on the track is 550 volts.

Fig. 16—THE LOT'S-ROAD POWER STATION

Fig. 17—MOVING STAIRCASE AT EARL'S COURT

The opening of the Central London Railway in 1900 resulted in a great annual reduction in the traffic on the Metropolitan and District lines, and in consequence the two companies devoted £20,000 towards equipping and working a short length of line between Earl's Court and High-street, Kensington, working on the ordinary continuous-current system. This experiment proving satisfactory, a joint advisory committee sat to consider which system should be adopted by both companies in common. This, however, resulted in much argument, for the Metropolitan Company favoured the three-phase system and the District Company the continuous-current system. The Board of Trade then appointed an arbitrator on the question, who recommended the continuous-current scheme, and this was eventually adopted on both railways. In 1902

the first contracts were let, and in 1905 electric trains were put into operation on the District and Metropolitan lines. As is well known, the Metropolitan trains run over the District Company's lines, hence the name Metropolitan District. The power station of the Metropolitan Railway is situated at Neasden, near Willesden, and here five large Westinghouse turbo-alternators are in operation. Three-phase current at a pressure of 11,000 volts is supplied to the sub-stations in which the usual rotary converters and static transformers are situated. The pressure on the Metropolitan Company's lines is 600 volts, and the same naturally applies to the District Railway. On these railways, and in fact on most where heavy currents have to be dealt with, the train motors are fed by a rail outside the track, whilst the current is returned to the sub-stations by means of a fourth rail. Fig. 14 shows a trailer car as used on the Metropolitan Railway. On the Metropolitan District Railway, and, in fact, on practically all the large electric railways, the trains are worked on the multiple unit system by means of a master controller in the driver's cab, motor and trailer coaches constituting the rolling stock. The Metropolitan District lines are supplied with current from the Lots-road power station at Chelsea, which was erected by the Underground Electric Railways Company of London.

Besides supplying current to the Metropolitan District lines this station also provides the current for the following tubes and tramways:—Charing-cross, Euston, and Hampstead, Great Northern, Piccadilly and Brompton, Baker-street and Waterloo, and the London United Tramways. This represents a total mileage of about 100 miles. The power station at Chelsea is known as the Underground Electric Railways Power Station, and the various lines mentioned above are connected with the Underground Electric Railways Company of London. It is impossible to enter into the details of all these railways, and even if it were, it would not be particularly interesting, since they are all operated on the same principle. The high-tension current is transformed down and converted in sub-stations and supplied to the conductor rails at a pressure of about 600 volts. The multiple unit control system with motor and trailer coaches is also used in each instance. In connection with the Metropolitan District Railway, however, it may be mentioned that there are no less than fourteen sub stations. Fig. 15 illustrates the interior of the Earl's Court sub-station, and shows the Westinghouse rotary converters and switchboard. This sub-station contains three rotary converters, each having a capacity of 1500 kilowatts. The motor coaches on the Metropolitan District lines are fitted with the British Thomson-Houston and Westinghouse Company's equipments. Whilst dealing with the District Railway reference may be made to the moving stairway which has recently been put into operation for connecting the Piccadilly and District stations at Earl's Court. So far as this country is concerned, this staircase, which is illustrated in Fig. 17, constitutes a new development in connection with electric transport, but in America transportation of this description is much more common. The Earl's Court moving staircase, however, is the first fixed in a tubular tunnel. It is designed to carry 10,800 people per hour from the Piccadilly to the District stations, and a similar number in the opposite direction. The Lot's-road power station, which is illustrated in Fig. 16, is the largest traction station in Europe. The site comprises 3¾ acres of land, with a water frontage on the Thames on the Chelsea Creek of 1100ft., and a frontage on Lot's-road, Chelsea, of 824ft. The electrical capacity of the station at normal load is 48,000 kilowatts. The south side of the building contains sixty-four water-

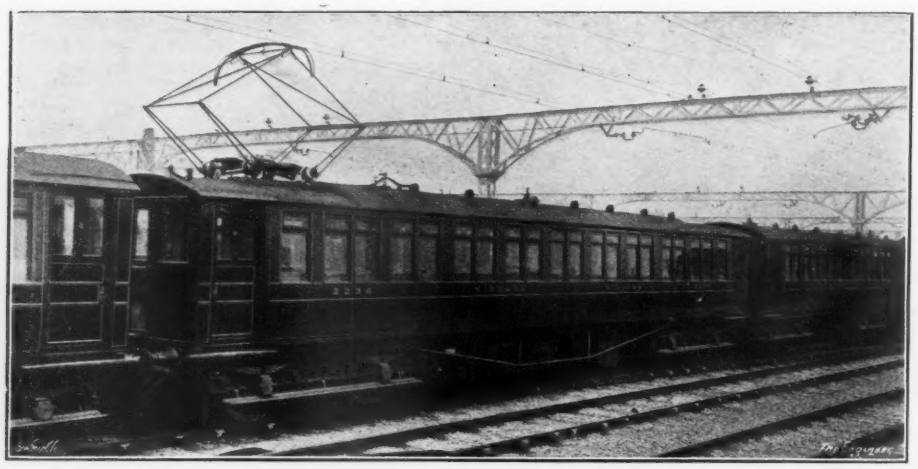


Fig. 18—TRAIN ON MIDLAND RAILWAY

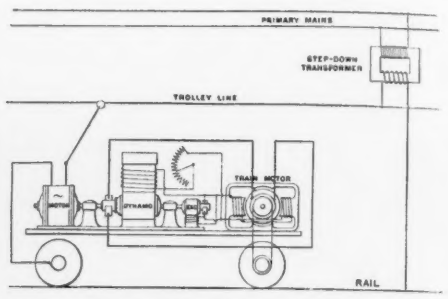


Fig. 21—WARD LEONARD SYSTEM

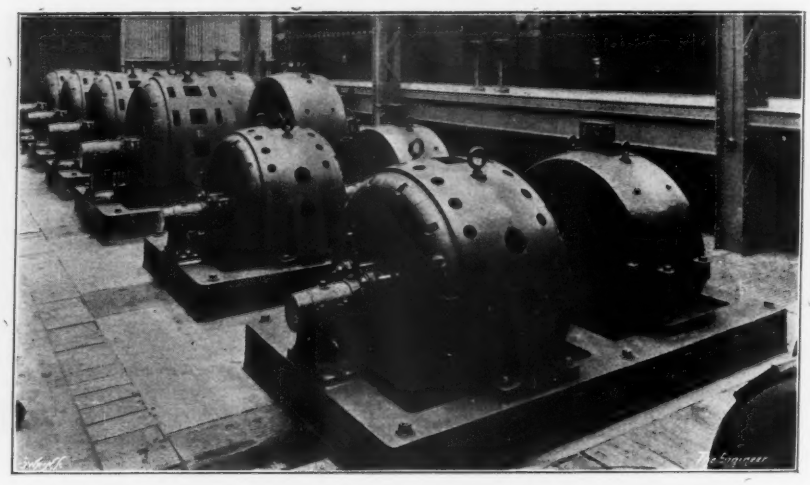


Fig. 20—PEEBLES CONVERTERS, GREAT WESTERN ELECTRIFIED LINES

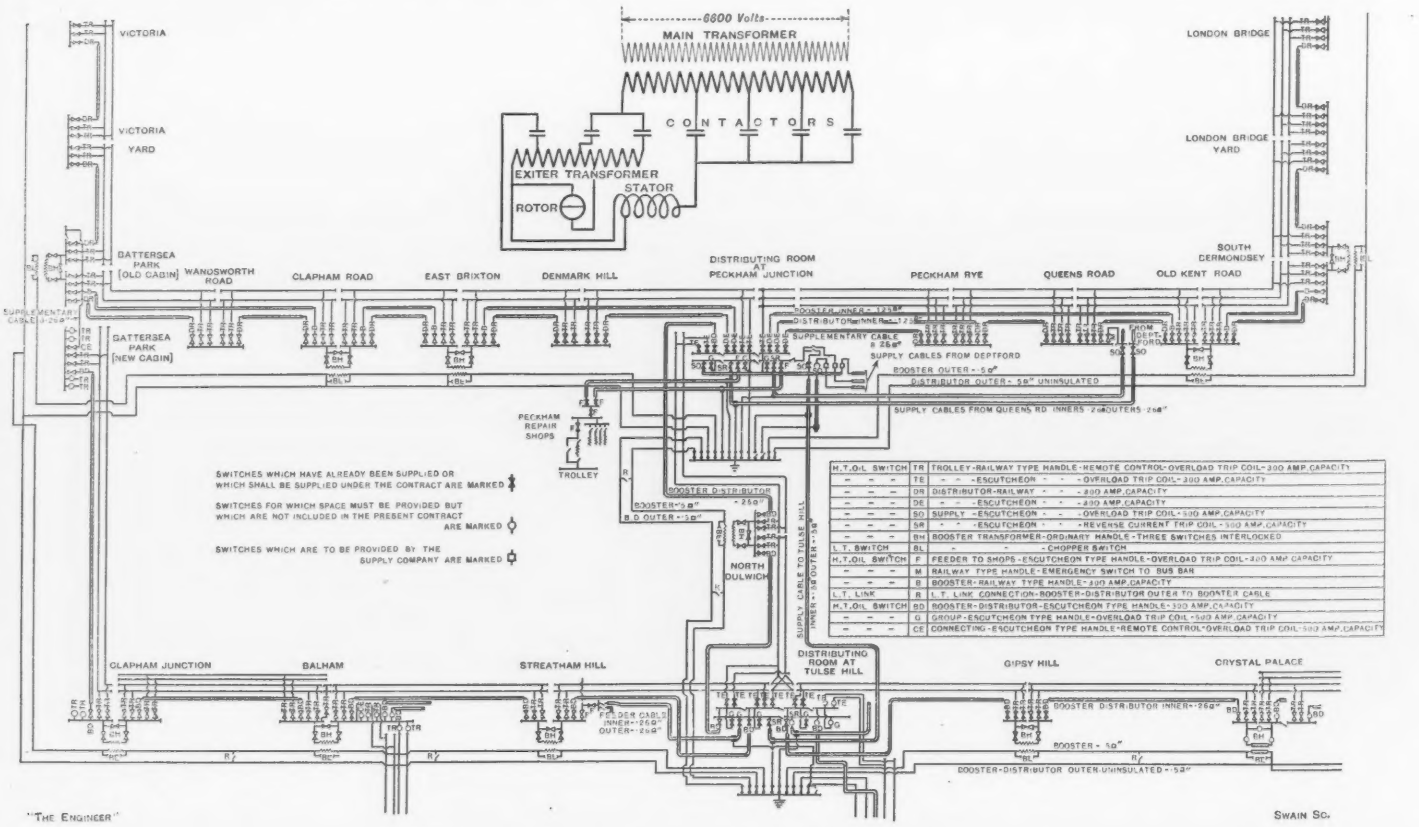

6600 Volts
MAIN TRANSFORMER
CONTACTORS
EXITER TRANSFORMER
STATOR
ROTOR
VICTORIA
VICTORIA YARD
BATTERSEA PARK [OLD CABIN]
BATTERSEA PARK [NEW CABIN]
WANDSWORTH ROAD
CLAPHAM ROAD
EAST BRIXTON
DENMARK HILL
DISTRIBUTING ROOM AT PECKHAM JUNCTION
PECKHAM RYE
QUEENS ROAD
OLD KENT ROAD
SOUTH DERMONDSEY
LONDON BRIDGE
LONDON BRIDGE YARD
PECKHAM REPAIR SHOPS
TROLLEY
NORTH DULWICH
CLAPHAM JUNCTION
BALHAM
STREATHAM HILL
DISTRIBUTING ROOM AT TULSE HILL
GIPSY HILL
CRYSTAL PALACE
SUPPLY CABLES FROM DEPTFORD
SUPPLY CABLES FROM QUEENS RD
SWITCHES WHICH HAVE ALREADY BEEN SUPPLIED OR WHICH SHALL BE SUPPLIED UNDER THE CONTRACT ARE MARKED
SWITCHES FOR WHICH SPACE MUST BE PROVIDED BUT WHICH ARE NOT INCLUDED IN THE PRESENT CONTRACT ARE MARKED
SWITCHES WHICH ARE TO BE PROVIDED BY THE SUPPLY COMPANY ARE MARKED
H.T.O-L SWITCH TR TROLLEY-RAILWAY TYPE HANDLE-REMOTE CONTROL-OVERLOAD TRIP COIL-300 AMP.CAPACITY
TE ESCUTCHEON OVERLOAD TRIP COIL-300 AMP.CAPACITY
DR DISTRIBUTOR-RAILWAY 300 AMP.CAPACITY
DE ESCUTCHEON 300 AMP.CAPACITY
SO SUPPLY ESCUTCHEON OVERLOAD TRIP COIL-300 AMP.CAPACITY
SR ESCUTCHEON REVERSE CURRENT TRIP COIL-300 AMP.CAPACITY
BH BOOSTER TRANSFORMER-ORDINARY HANDLE-THREE SWITCHES INTERLOCKED
L.T. SWITCH BL CHOPPER SWITCH
H.T.OIL SWITCH F FEEDER TO SHOPS-ESCUTCHEON TYPE HANDLE-OVERLOAD TRIP COIL-300 AMP CAPACITY
M RAILWAY TYPE HANDLE-EMERGENCY SWITCH TO BUS BAR
B BOOSTER-RAILWAY TYPE HANDLE-300 AMP.CAPACITY
L.T. LINK R L.T. LINK CONNECTION-BOOSTER-DISTRIBUTOR OUTER TO BOOSTER CABLE
H.T.OIL SWITCH BD BOOSTER-DISTRIBUTOR-ESCUTCHEON TYPE HANDLE-300 AMP.CAPACITY
G GROUP-ESCUTCHEON TYPE HANDLE-OVERLOAD TRIP COIL-500 AMP.CAPACITY
CE CONNECTING-ESCUTCHEON TYPE HANDLE-REMOTE CONTROL-OVERLOAD TRIP COIL-500 AMP.CAPACITY
"THE ENGINEER"
SWAIN Sc.

Fig. 19—FEEDER CONNECTIONS ON LONDON AND BRIGHTON RAILWAY

tube boilers arranged in two stories. Floor space is available for sixteen additional boilers. Each of the eight 5500-kilowatt main generating sets consists of a horizontal Parsons turbine running at 1000 revolutions per minute, and a three-phase generator wound for 11,000 volts and 33⅓ cycles per second. Floor space is available for two more of these sets, and also for a set of half the above mentioned capacity. Each generator is designed for an overload of 50 per cent. for two hours. The present output of the station is 144 million units per annum, and the daily coal consumption about 400 tons.

In 1906 the Great Western Company started running trains over the electrified section between Bishop's-road and Hammersmith and Addison-road, which includes the Great Western additional lines, the West London lines, and the Hammersmith and City Railway, the latter being jointly owned by the Great Western and Metropolitan Railways. The Great Western Company's power-house is situated at Park Royal. Current is supplied from this station at a pressure of 6600 volts to three sub-stations. Here it is transformed and converted into direct current at a pressure of 600 volts for traction and at a pressure of 110 volts for lighting. An interesting point in connection with this line is the use of Peebles motor converters in the sub-stations. The illustration, Fig. 20, shows six of these machines in the Royal Oak sub-station. Four of these sets have a capacity of 400 kilowatts and two 200 kilowatts. There are also seven 400-kilowatt motor converters in the Shepherd's Bush sub-station. Buffer batteries are also used in connection with this line. The rolling stock consists of twenty motor and forty trailer cars. Each motor car is fitted with four of the British Thomson-Houston Company's 150 horse-power motors, and they are operated on this firm's multiple unit control system.

Fig. 22—TRAIN ON LANCASHIRE AND YORKSHIRE RAILWAY

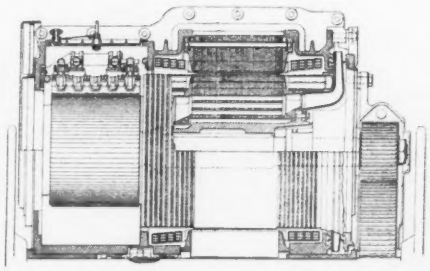


Fig. 23—SECTION OF MOTOR

All the railways so far considered are operated on the continuous-current system, although many employ three-phase transmission. We have now, however, to consider single-phase working, and this takes us to an entirely different class of railway, namely, where electrification is carried out on main lines. For many years it appeared that single-phase current was quite unsuitable for railway work, and it was not until 1891 that a proposal to use it in this connection was put forward. In this year Mr. Ward Leonard patented a scheme similar to that shown in Fig. 21, where the alternating current is changed into continuous current by means of a motor generator on the trains. The illustration is from a paper read before the Institution of Civil Engineers in 1902 by Messrs. Mordey and Jenkins. The authors proposed to use an induction motor for the alternating side of the motor generator, whereas Mr. Ward Leonard advocated a synchronous machine. By varying the excitation of the generator any voltage can be applied to the terminals of the motors driving the train. It is obvious that the main objection to such a scheme is the great weight of the electrical equipment on the train. On the other hand, it is extremely economical as regards speed variation, since all regulation is done on the generator field. The advent of the alternating commutator motor, however, considerably simplified the problem, and examples of single-phase working are becoming common. It is not our intention to enter upon a lengthy discussion on the merits and demerits of the single-phase system, but it may be remarked in passing that one of its advantages is that it lends itself to long distance extensions. For railways such as the District, the City and South London, the Central London, and the various other London lines that have been referred to and which are not likely to be extended more than a few miles the continuous-current system is quite good. But when it comes to extending the electrified sections of main lines so that the electric trains run long distances, then the ordinary low voltage continuous-current scheme with heavy cables and sub-stations becomes commercially impracticable. Many engineers who have adopted the continuous-current

Fig. 25—TRAIN ON LIVERPOOL OVERHEAD RAILWAY

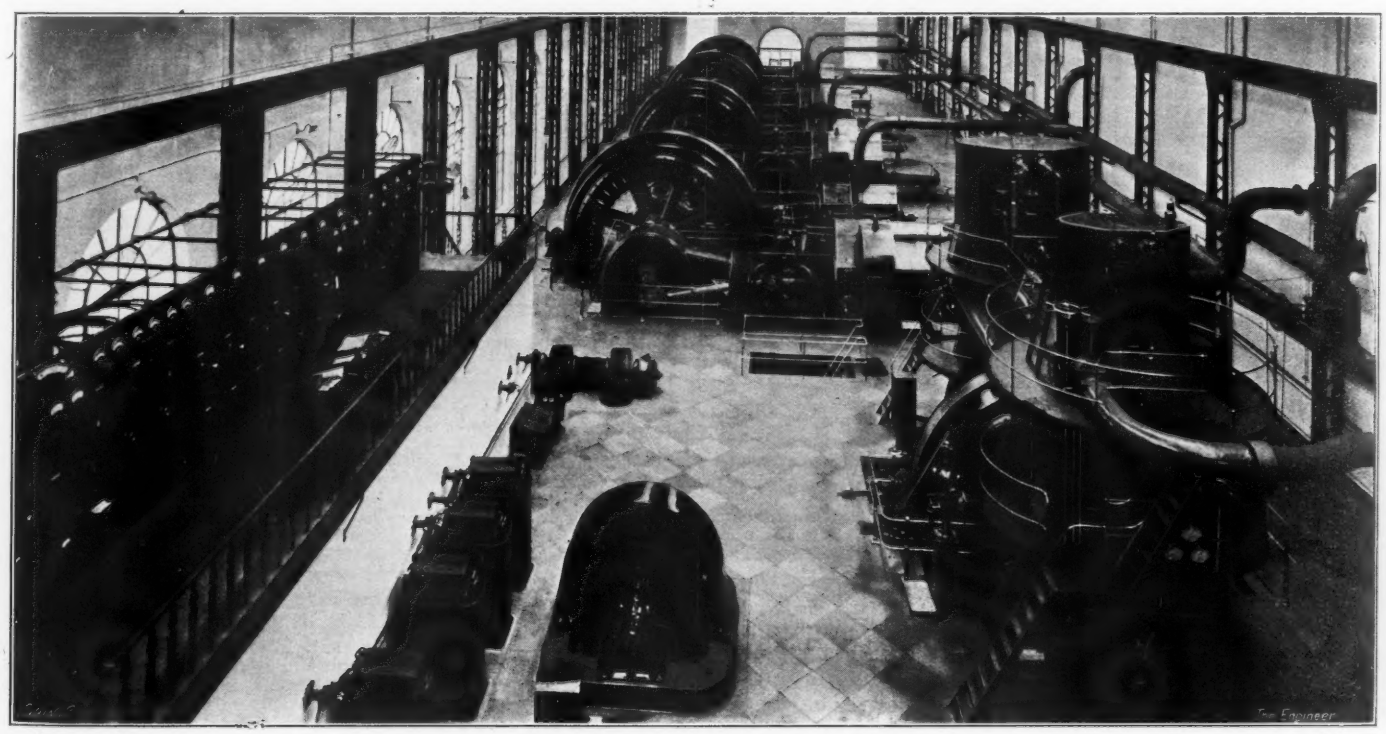


Fig 24—LANCASHIRE AND YORKSHIRE RAILWAY POWER STATION

system on main lines in this country hold that they can clear the difficulty by using a mixed system, but whilst it is claimed that the single-phase scheme is as economical to work as the direct-current system, it is well to consider whether this practice is expedient. Certain engineers maintain that the high-tension direct-current system has a considerable future before it, and that it can be made to meet the requirements of long-distance main line working. It has recently been stated that "there is no reason why direct current at 3000, 4000, and perhaps even 6000 volts should not be used without incurring

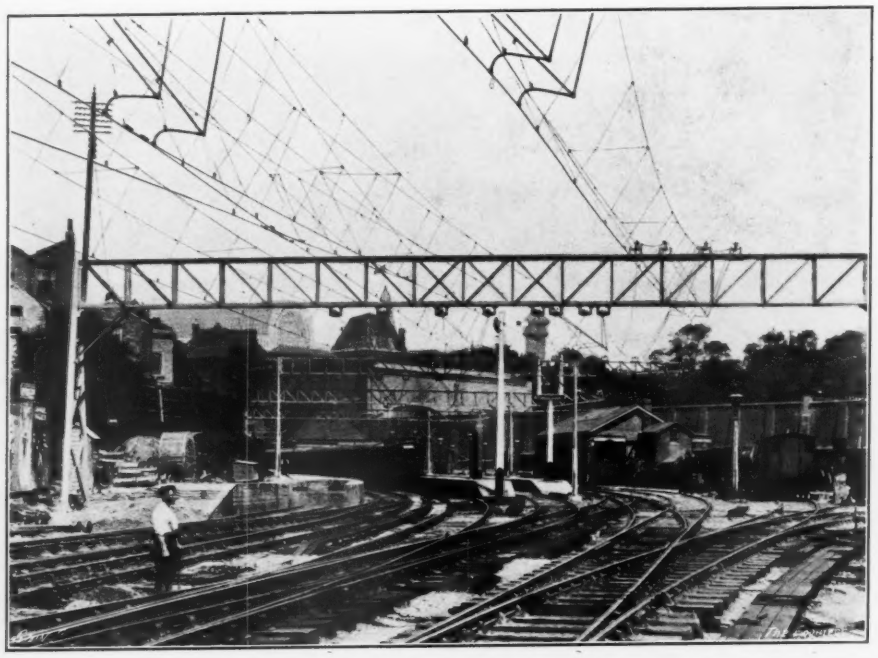


Fig. 26—OVERHEAD EQUIPMENT AT THE CRYSTAL PALACE

risk or trouble. It is well to note, however, that the last-mentioned voltage is needed for long-distance working.

The two examples of single-phase working in England are to be found on the Heysham, Morecambe, and Lancaster section of the Midland Railway, and on a portion of the suburban system of the London, Brighton and South Coast Railway. The first portion of the latter company's lines to be electrified was that between Victoria and London Bridge. This was opened on December 1st, 1909, and the second portion, which was brought into service this year, provides a connection between Victoria and the Crystal Palace, and when sufficient power is available a service to London Bridge *vid* the Palace will be opened. The electrified section of the Midland Railway previously referred to was opened on April 13th, 1908, and was the first example of single-phase working in this country. The pressure used on this line is 6600

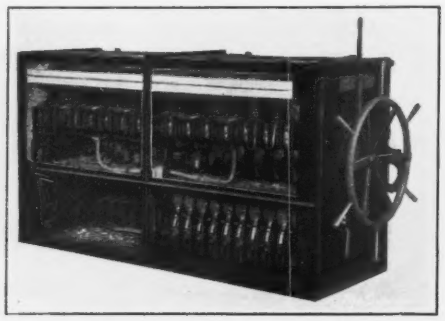


Fig. 27—CONTROLLER

volts, and the periodicity 25 cycles per second. The line is worked by a gas-driven plant. The trains are made up of three cars, one motor car, and two trailers. Siemens Brothers and the Westinghouse Company were responsible for the electrical equipment of the trains, and the latter firm also supplied a new gas-driven generating set for use in the existing power-house, which was originally built for working the cranes, capstans, lifts, and other machinery in the harbour at Heysham. A full description of the Midland Railway electrified lines will be found in THE ENGINEER for June 10th, 1910. Fig. 18 shows one of the Westinghouse trains on this line.

Turning again to the London Brighton scheme, for which Mr. Philip Dawson was the consulting engineer, and under whose direction the whole of the work was executed, it will be seen from the diagram of the feeder connections, shown in Fig. 19, that the overhead system is arranged in sections, so that a complete division exists between each station and the next, the up and down lines also being entirely separate. At Victoria and London Bridge this could not be done in consequence of the very complicated nature of the work, but a zone comprising all the complicated crossings was solidly connected and fed separately. Power is taken from the London Electric Supply Corporation's mains power station at Deptford, and, as will be seen from the diagram, Fig. 19, the feeder cables enter the Brighton Company's property at Queen's-road switch cabin. It will also be noticed from this diagram that boosters are used at various points in order to cause the major part of current used to return through the booster cables and not through the rails. These boosters, which are naturally of the static type, are situated in the various switch boxes at points along the line. The illustration—Fig. 26—gives a view of the overhead equipment at the Crystal Palace. The trains are made up in units of two or four coaches, consisting of one motor and one trailer coach, or two motor coaches and two trailers. At the time when the line was first opened the largest motor obtainable was a 115 horse-power machine, and this gave rise to the use of a three unit train, but in the case of the later trains each motor coach is fitted with a four horse-power 150 horse-power motor, which enables the trains to be made up in the manner described. The primary voltage used on this line is 6000, and that on the motors 450, as against 340 on the Midland Railway. The motors are of the compensated repulsion Winter-Eichberg type, and are similar to those fitted to the first set of motor coaches on the Hamburg-Blankenese line. The connections to the transformer are shown in the upper part of Fig. 19, whilst Fig. 23 gives a section of one of the motors. The contractors for the whole of the equipment of the South London electrification, excluding the coaches, were the Allgemeine Elektricitäts Gesellschaft of Berlin. The builders of the coaches were the Metropolitan Amalgamated Carriage and Wagon Company, and the sub-contractors for the whole of the overhead line work, incluing feeders and switch gear, were R. W. Blackwell and Co., who in turn sub-contracted for the switch gear and the wires and cables.

Up to the present we have only considered one case of electrification in the provinces, and this was done merely in order to take all the single-phase together, but we shall now deal with the remainder of the provincial lines. The Liverpool Overhead Railway, which commenced working in March, 1893, was the first elevated line in the world operated with electricity. The total length of the line is about 6½ miles. It is carried on steel columns with a normal span of 50ft. A great deal about this railway in its early stages is to be found in Vol. lxxv. of THE ENGINEER for the year 1893. After some years' working, however, the line was re-equipped by Dick, Kerr and Co. With the old equipment the entire distance was run in 32 minutes, including 16 stops, or practically at a scheduled speed of 12½ miles per hour. This necessitated a minimum of 14 trains running at five-minute intervals to cope with the traffic. The firm of Dick, Kerr and Co., guaranteed to run the whole distance, including 16 stops of 12 seconds in 20.9 minutes. In other words, to improve the schedule speed from 12½ to nearly 19 miles per hour. When the work had been completed a test made by the chief engineer of the railway demonstrated that the new trains would easily cover the journey under 20½ minutes. It was found that the acceleration reached 4.2ft. per second per second, or nearly three miles per hour per second, the average acceleration being well over one mile per hour per second, thus enabling the train to cover the 2110ft. between the stations in little over one minute

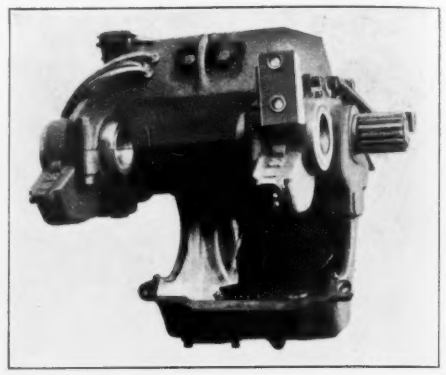


Fig. 29—COMMUTATING POLE, TRACTION MOTOR

including starting and stopping. There is, of course an obvious limit to the acceleration on any line, the limiting factor being the discomfort of the passengers. As will be gathered from the illustration—Fig. 25—some of the trains are made up of three coaches. The voltage on the track is 500. In the generating station there are six horizontal compound engines driving Elwell Parker dynamos and a Browett-Lindley compound engine driving a Dick-Kerr generator.

The opening of the electrified Mersey Railway in 1903 did much in the way of demonstrating the advantages of electric traction for underground working. The troubles inseparable from a long tunnel in which frequent steam-propelled trains are run had previously hindered the railway's progress. The objectionable atmosphere in the tunnel became more and more trying as the years

Fig. 28—TRAIN ON NORTH-EASTERN RAILWAY

advanced; working expenses increased and business fell away in consequence. When the change from steam to electric working was made, however, the line at once became popular, and it has been worked much more satisfactorily ever since. The electrification of this line was carried out by the Westinghouse Company. It is worked on the continuous-current system, and is supplied with current from a power station at Shore-road, Birkenhead. The pressure is 600 volts. In accordance with the practice adopted on the Metropolitan District Railway, two separate feeder and return conductors are used. The trains are made up of motor and trailer coaches, and are operated on the Westinghouse multiple control system.

To Dick, Kerr and Co. belongs the distinction of being the first firm in England to carry out a real main line electrification scheme. This was on the Lancashire and Yorkshire Railway, where electric trains were put into operation in the summer of 1904. Various extensions have been made since then, and it is common knowledge that the scheme has proved very successful. A great

deal of interesting information concerning the electrified lines of the Lancashire and Yorkshire Railway was brought to light in Mr. Aspinall's presidential address before the Institution of Mechanical Engineers. The scheme constitutes a good example of continuous current working on main lines, with high-tension three-phase transmission. Current is generated at the power-house at a pressure of 7500 volts, and transmitted to sub-stations. Here the pressure is reduced by means of static transformers, and the current is changed from rotary converters situated in sub-stations. The track work and the electrical equipment of the cars was placed in the hands of the British Thomson-Houston Company, of Rugby, and the trucks, underframes, and cabs were built by the Brush Company. Each motor coach is equipped with two 150 horse-power motors, and the control is on the Sprague, Thomson-Houston multiple unit system. The illustration, Fig. 28, shows one of the trains on this railway. It will be gathered that the current is collected from a third rail outside the track,

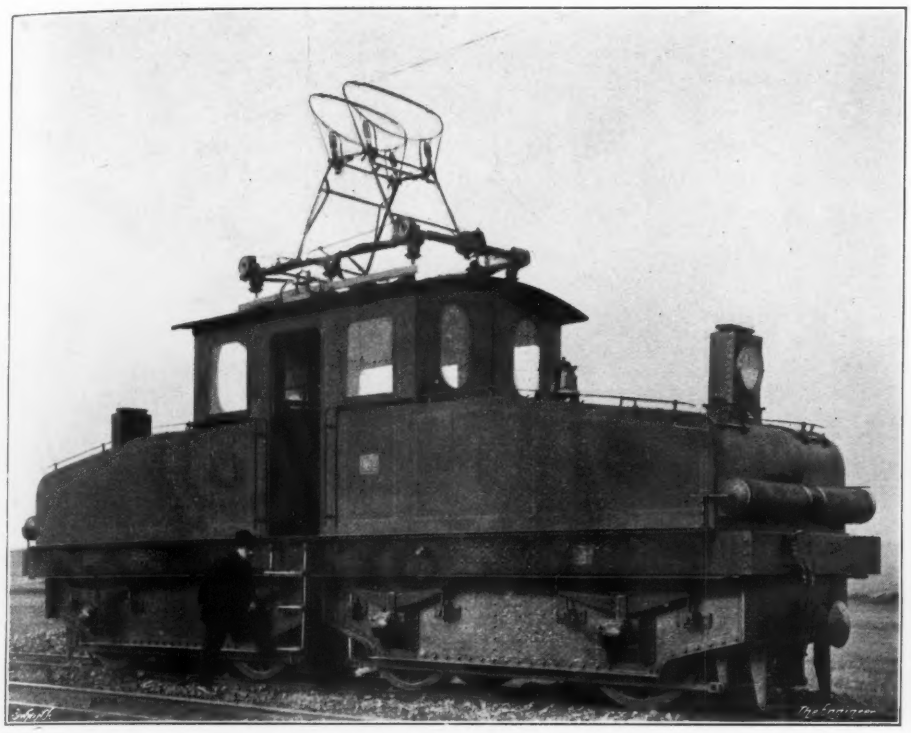


Fig. 30—2000-VOLT CONTINUOUS-CURRENT LOCOMOTIVE

alternating to direct current by means of rotary converters. The pressure supplied to the trains is 600 volts. The power house stands approximately at the centre of the line, and is on the banks of the river Alt. In addition to the generating plant it contains converting machinery, so that part of the electrical energy generated is distributed direct to the adjacent track. There are also sub-stations at various points along the line. A view of the power-house is given in Fig. 24. An interesting point in connection with this railway is the extensive use of storage batteries for equalising the load on the generators. The great advantages derived from these batteries was explained by Mr. Aspinall in his presidential address, and the Lancashire type of reversible booster used in connection with the railway was dealt with in our recent articles on boosters. The standard electric trains used on the Lancashire and Yorkshire electrified lines consist of two first and two third-class cars, the latter being at either end and equipped with two motor bogies, each carrying two 150 horse-power motors. Thus there are

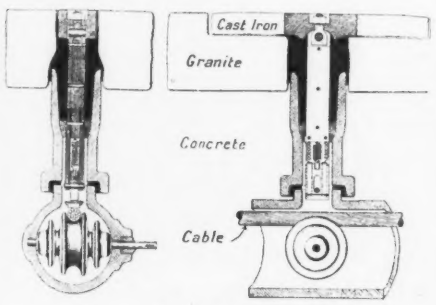


Fig. 31—G.B. STUD

eight motors to each train. A train of this description is shown in Fig. 22. The current is fed to the motors from a rail outside the running rails, and is returned to the sub-stations through a rail in the centre of the track. Prior to the electrification of the Lancashire and Yorkshire system it was frequently contended that the only system of control which met railway service conditions was the multiple unit system; but on this line both direct control and the multiple unit system are in use. In the former case a special controller, designed by Dick, Kerr and Co., is used, which is said to give very satisfactory results.

Another example of electrification of this description is to be found on the Newcastle local lines of the North-Eastern Railway, which were electrified in accordance with the designs of Mr. Charles H. Mertz. Here, again, we have continuous current working at a pressure of 600 volts on the track. Three-phase current for working this line is derived from the well-known Carville power-house at a pressure of 5500 volts. The pressure is reduced and the three-phase current changed into direct-current by means of the usual static transformers and whilst the running rails serve as the return. Some British Thomson-Houston locomotives are used in connection with this line. It is a well recognised fact that whatever system may be adopted for railways, a high pressure is desirable. The greater the pressure the smaller the cables and the farther apart may be the feeding points. In the case of the majority of the continuous-current electric traction systems at present in operation, the pressure applied to the terminals of the motors is in the neighbourhood of 500 or 600 volts; but of late years there has been a tendency to exceed these pressures. For examples of high-pressure continuous current working we must turn to America and the Continent, but in the present instance we do not intend to consider more than one of these examples. The scheme to which we propose to direct attention is a 2000 volt continuous-current railway, which has been put into service at the Mosel blast furnaces belonging to the Rombacher Huette, in Maizières, Lorraine. The line, which was electrified by Siemens-Schuckert, is 8.7 miles long, and at the present time carries about 2600 tons of ore per day There were various reasons for adopting such a high-pressure continuous-current scheme, but these cannot be entered into here. One of the difficulties was the narrow (1 m.) gauge, and another that the line had to be fed from both ends. A locomotive used on this line is shown in Fig. 30, from which it will be gathered that it is built on the four-wheel bogie principle. Each of the four axles is driven through gearing by means of a 160 horse-power motor. The motors, which are fitted with commutating poles, are permanently connected in two groups of two in series. There is thus 1000 volts across the terminals of each motor. From the illustration it will be noticed that the overhead line has two trolley wires, which are supported by a double hanger in such a manner that both wires are always in contact with the bow of the locomotive. The return circuit is through the running rails. A controller as used on the locomotives of this line is shown in Fig. 27. In this case multiple unit control is unnecessary, as the locomotives are never coupled together. A great deal might be written about this interesting line, but we cannot enter into further details in the present instance. The secret of being able to use high voltage on continuous-current traction motors is to be found in the use of commutating poles. Not only are these poles desirable in motors working at high pressures, but also in those used on the ordinary tramway and railway systems. Several firms in this country have adopted this practice, and notably Dick, Kerr and Co. and Siemens. A standard commutating pole traction motor, as manufactured by the latter firm, is shown in Fig. 29. Although this motor is suitable for the usual series parallel method of control, it is specially adapted for a system which has recently been re-introduced by this firm. This system is an extension of the ordinary series parallel control scheme. The motors are started up in the ordinary manner until the full series stage is reached. The excitation of each motor is then reduced by 50 per cent.; the motors are then put in parallel with resistance in circuit with full excitation. The series resistance is next cut out and the motors are then in full parallel. On the following step of the controller the excitation of each motor is reduced by 33 per cent., and finally on the last step the excitation is reduced by 50 per cent. For braking purposes the field excitation is maintained at its full value. The excitation is, of course, varied by shunting the series windings.

Before leaving the subject of electric railways, we should point out that with the exception of Davidson's car, which was run on the Edinburgh and Glasgow in 1842, in all the examples we have considered, current is supplied to the motors from a stationary generating station. We should not omit to mention, however, that several inventors have placed the generating plant on wheels. Perhaps the best known example of this kind is the Heilmann locomotive, which was run on the Western Railway in France in the early nineties. This locomotive carried an engine and a dynamo, the latter supplying current to the motors driving the wheels. In short, it was an early example of electric transmission as is now used on petrol-electric omnibuses. The advent of the steam turbine has been the means of giving rise to another

Fig. 32—TRAMCAR AT LINCOLN

experiment of this kind on a railway. Early last year trials were made by the North British Locomotive Company with the object of ascertaining the performance of a steam turbine locomotive in which electric transmission gear is used. This locomotive was described in The Engineer for June 10th, 1910, and we need not enter into details here.

On the Continent considerable progress is being made with the use of a combination vehicle on petrol-electric lines, that is, an internal combustion engine driving

electrical generating plant, with motors attached to the axles or driving equipment. At a meeting of the Institution of Mechanical Engineers held in November of last year, Mr. W. P. Durtnall drew attention to the advantages of this class of vehicle for certain classes of railway and tramway work, and towards the close of the meeting the

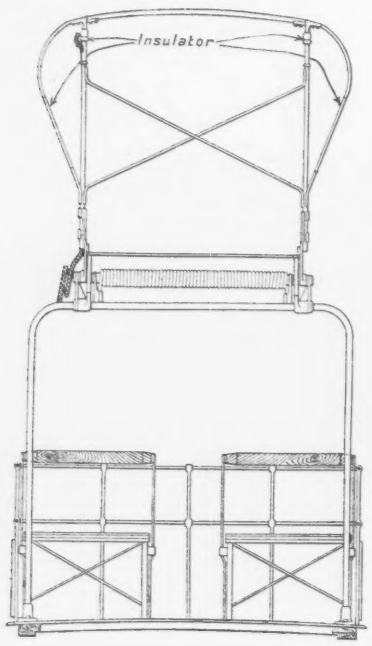


Fig. 33—TRAMCAR, BOW

President, Mr. J. A. F. Aspinall, remarked that if anyone chose to go so far as Austria-Hungary he would find in one place alone sixty trains of that kind running upon one railway. Those vehicles, Mr. Aspinall said, were reported to be performing their work very economically, and they embodied an interesting mechanical arrangement about which he had no doubt a great deal more would be heard in the future.

In considering electric tramways we do not propose to do more than to direct attention to the various systems in use. So far as the actual equipment of the cars is concerned, this is very much the same in all cases, and it is only in the method of collecting the current that any real difference is to be found. Three distinct systems of collecting the current have been put into use in the United Kingdom, *i.e.*, the overhead or trolley system, the conduit system, and the surface contact system. Most of the electric tramways in existence, however, are worked on the trolley system. This arises from the fact that its first cost is low, it is cheap to maintain, and very reliable in action. It is true that the overhead system with its trolley wires, guard wires, bracket arms and poles frequently destroys the open aspect and architectural merits of a well-laid street, but objections to its use are less numerous now than they were in the past. One of the greatest difficulties met with in connection with the overhead system is at points where the tramway has to pass underneath low bridges where there is insufficient head room to allow the wires to be carried at a safe distance above the car. The conduit and surface contact systems were introduced with the object of overcoming these drawbacks, but up to the present the overhead system has held its own. The slot conduit system certainly obviates the above mentioned troubles, but, on the other hand, its initial cost is higher, and it is more expensive to maintain. The conduit system was first tried at Blackpool in 1884, where a short line was laid along the sea front. The conduit, however, was frequently flooded with sea-water, and in consequence the experiment proved unsuccessful. It was not until after several years' working, however, that the system was abandoned. The next appearance of the conduit system was at Bournemouth, where objection was raised to the use of overhead wires in the town. Here we have an example of the mixed system, the cars being worked from the underground conductors in parts where the appearance of the roads is of consequence, and with the overhead wire in the outlying districts. A notable example of the use of the conduit is to be found on the London County Council tramways. The length of route is about 128 miles and the greater part is worked on the conduit system. The surface contact or stud system is in use at Wolverhampton and Lincoln, and it has also been tried at Torquay and Hastings, and on the London County Council tramways. The system in use at Wolverhampton is the Lorain system, and that at Lincoln the Griffiths-Bedell. The illustration—Fig. 31—gives a cross-section of conduit through the centre of the Griffiths-Bedell stud, and also a longitudinal section of conduit through the centre of the stud, with the switch piece in the up position. When the collector on the vehicle covers a stud a magnet on the car draws the lower part of the stud into contact with the cable against the pull of the spring and current is conveyed to the motors. When the car passes the stud and the pull of the magnet is removed, the spring lifts the lower part of the stud off the cable and the circuit is broken. Fig. 32 shows a car on the track at Lincoln.

Fig. 35—ELECTRIC BROUGHAM

There is one other point which we should consider in connection with electric tramways, and that is in relation to the use of the ordinary trolley arm and the bow. Much discussion has taken place as to which is preferable for tramway use, but so far as we are aware the bow is only employed on one English tramway, namely, at Sheerness. In connection with shunting locomotives and high-speed trains running on main lines, however, we find many examples of its application, for the simple reason that the trolley arm is unsuitable for this class of service. Moreover, in the case of main line trains which have to travel at express speeds, the ordinary trolley must be replaced by some form of catenary system, as used on the single-phase lines of the Midland and London-Brighton railways.

In the case of electric tramways the trolley arm system

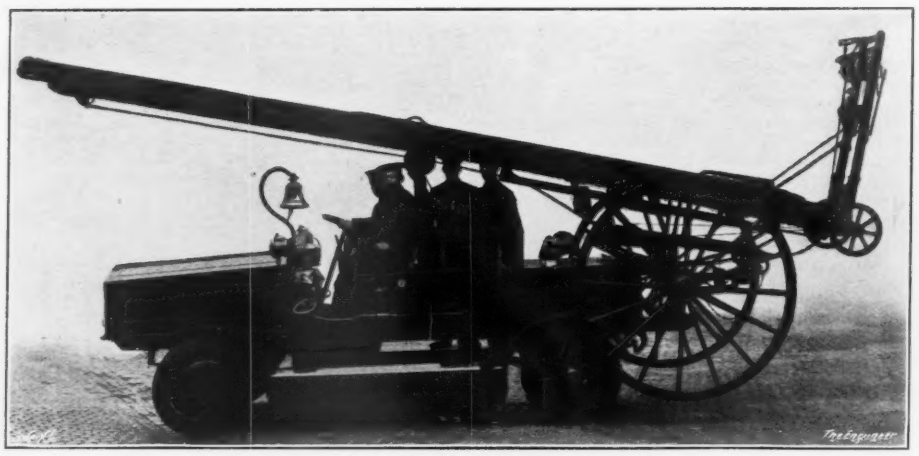


Fig. 34—"CEDES" FIRST-AID VAN

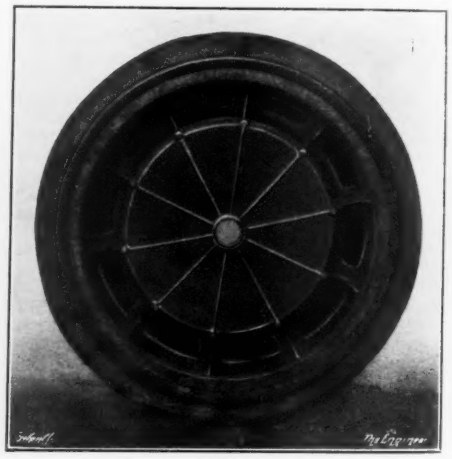


Fig. 37—THE WHEEL

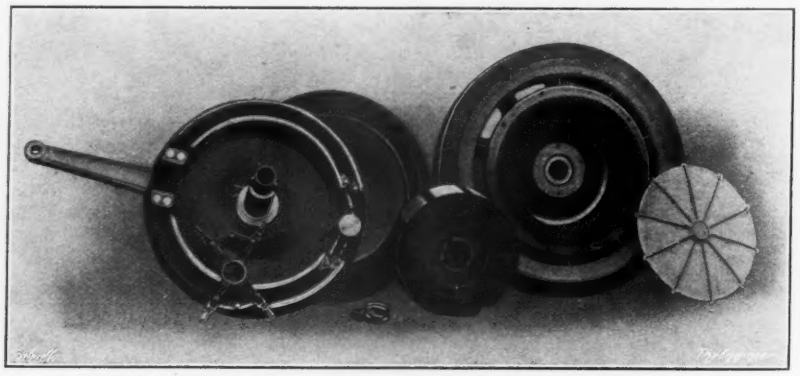


Fig. 38—PARTS OF MOTOR

is fairly satisfactory, but some engineers maintain that the bow is preferable. The advantages claimed for the bow are that if the line is properly erected this form of collector cannot leave the trolley wire and wreck the overhead equipment, as sometimes occurs with the trolley pole. It is on sharp curves and down gradients that this advantage is most marked, as it increases the security of the line and relieves the conductor of the troublesome business of supervising the trolley pole where the car passes round curves. Another advantage put forward by the advocates of this system of collecting the current is the automatic reversibility of the bow when the car changes its direction of running. The illustration, Fig. 33, shows a bow as supplied for tramway use by Siemens Brothers for a double-deck car without a top cover. Perhaps one of the most important advantages put forward for the bow type of current collector is that it saves wear on the trolley wire.

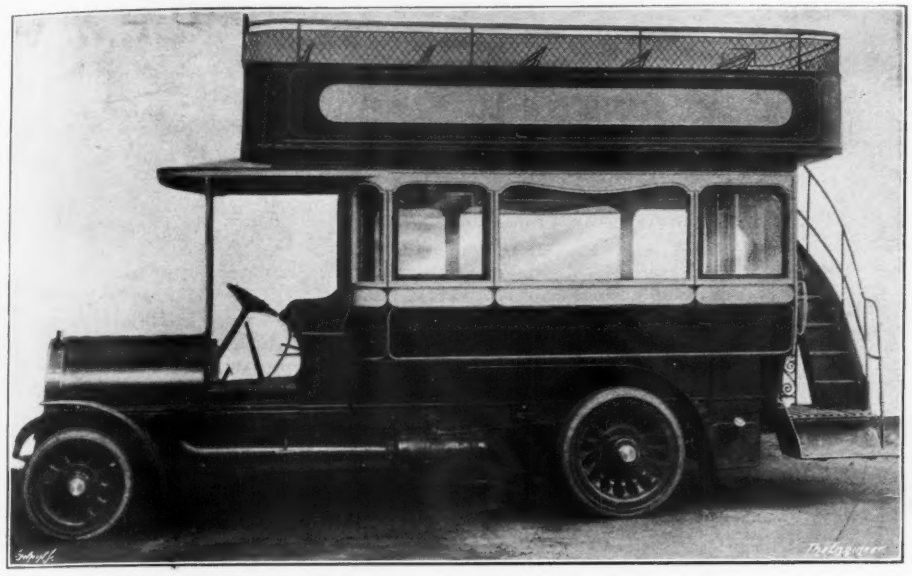


Fig. 38—HART-DURTNALL PETROL ELECTRIC OMNIBUS

ROAD VEHICLES.

Road vehicles worked with storage batteries are by no means common in this country, and it does not seem probable that they will ever meet with extensive use. From time to time omnibuses, cabs, &c., which derive their power from accumulators, have been placed on the London streets, but up to the present the majority of these schemes have proved a commercial failure. It is somewhat surprising that central engineers have not done more in the way of encouraging this form of locomotion, for charging might be carried out at night with a beneficial effect upon the load factor. In 1903 Mr. W. H. Hibbert read a paper before the Institution of Electrical Engineers on "The Edison Accumulator for Automobiles," and the tests he described made the cell appear promising, but so far this type of battery has not replaced the ordinary lead accumulator. In the wealthy parts of London a certain number of electric carriages are to be found, and many of these are built by the Electromobile Company, of Mayfair. The illustration—Fig. 35—shows one of this company's electric carriages. The main features are the straight chassis and the underslung interchangeable battery. One type of chassis is used for all the company's town carriages, viz., the landaulette, for two or four people; the brougham, and the victoria. The underslung battery has been adopted to obtain four advantages, namely, rapid interchangeability, even distribution of weight on the wheels, the collection of all the cells in a single box, and a low centre of gravity. The battery consists of 45 E.P.S. cells of a special type, and weighs about 10 cwt. Its capacity is 120 ampère hours, and affords sufficient power to propel the victoria about 35 miles and the laundalette 30 miles over roads in fair condition. The motor is capable of developing 8 brake horse-power continuously at a speed of 1500 revolutions per minute; but it can safely exert over 16 horse-power for short intervals. The controller gives forward speeds ranging from three to fifteen miles per hour and one reverse speed. The vehicle is also equipped with an electric brake.

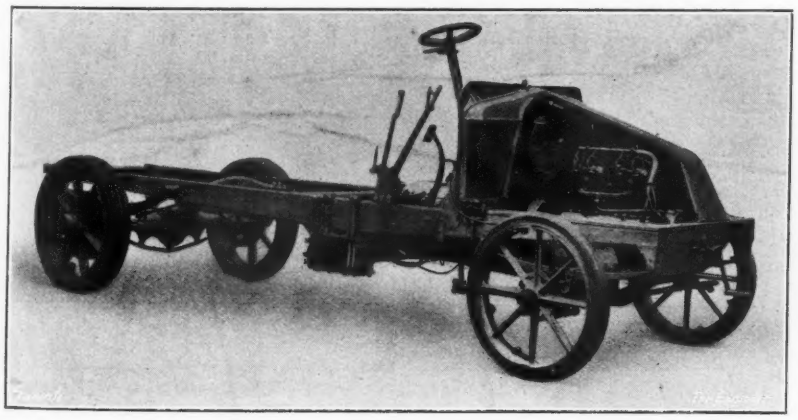


Fig. 39—CHASSIS FOR STEVENS PETROL ELECTRIC OMNIBUS

The Cedes Electric Traction Company, of Great Portland-street, W., appears to have done a considerable amount of work of this description on the Continent, and Johnson and Phillips, of Charlton, are the builders of the "Cedes" electric vehicles in England. This company builds many kinds of battery-worked vehicles, including omnibuses, commercial cars, fire engines, and ambulance cars. We are informed that the Vienna fire authorities recently tested the "Cedes" electric system against horses, petrol, and steam-propelled vehicles, and found the former system the most economical of the four. The illustration—Fig. 34—shows a "Cedes" first aid van as supplied to the London Fire Brigade. The total weight, including men and all equipment, is 5 tons 10 cwt. On a level road the speed is 26 miles per hour, and on a gradient of 1 in 12, 15 miles per hour. The battery is capable of running the vehicle 40 miles on an average road with a single charge. An interesting point about the "Cedes" vehicles is that the motors are built into the hubs of the wheels, as shown in Fig. 37. Moreover, the armature winding and core surround the field system. The illustration—Fig. 36—shows the various parts of the motor, from which it will be gathered that the field system is mounted direct on the axle, whilst the armature is built in the wheel. A radial commutator is also used on these motors, which eliminates chattering of the brushes when the vehicle is running over uneven roads. The cable transmitting the current passes through the axles.

There is but little doubt that the advent of the petrol engine did much in the way of retarding the progress of the battery vehicle, and particularly vehicles such as omnibuses and pleasure cars. This engine, however, whilst possessing properties which make it suitable for road locomotion, needs to be used in conjunction with a gear box. This sometimes gives rise to noise, and it also has certain other disadvantages which are much emphasised by those who advocate electrical transmission. Numerous schemes have been introduced for controlling petrol vehicles electrically, but although much ingenuity has been exercised in this direction up to the present time it cannot be said that the scheme has met with widespread favour. At the same time, however, some very excellent petrol-electric omnibuses are in use, and there is evidence to show that they have recently made headway. No attempt can be made to enter into descriptions of the various schemes that have been put forward, but we may direct attention to one or two systems that have been put to the test of practical application. In passing, however, it may be mentioned that one of the earliest systems was the Patton scheme, which was tried on electric tramcars in America. In this scheme electric tramcars were used carrying a set of accumulators and a small petrol engine driving a dynamo. The latter was used for charging the battery, and the engine was kept fully loaded, whilst the accumulators supplied current to the motors.

One of the most interesting petrol-electric omnibuses that have been designed was the Hart-Durtnall omnibus, in which three-phase transmission gear was used. An idea of the general scheme can be gathered from Fig. 40, whilst Fig. 38 gives a view of the actual vehicle. The stator of the motor had two windings, so that with a fixed speed of the engine the speed of the motor could be changed, and the third speed was obtained by connecting the engine direct to the shaft by means of a magnetic clutch. The voltage of the generator was varied by altering the amount of resistance in circuit with the series winding of the exciter. With the regulating switch at the point X the motor would be subjected to a high voltage, under which conditions it was found to develop sufficient torque to start the vehicle, notwithstanding that the motor was a squirrel-cage machine. When starting with a heavy load the winding giving the highest number of poles on the motor was used, and afterwards the other winding was brought into action. When the vehicle had attained speed the regulating switch was moved on to the contact Y. This operation caused the winding of the magnetic clutch to be connected in series with the field of the generator. The last movement of the regulating switch on to the contact Z caused the bridge piece S to short-circuit the generator field winding. Under these conditions the exciter only supplied current to the clutch winding, and the engine was therefore directly connected to the driving shaft, whilst the other electrical gear was inoperative. There are other interesting points connected with the scheme, but the foregoing will serve to show the general principle on which this omnibus was worked.

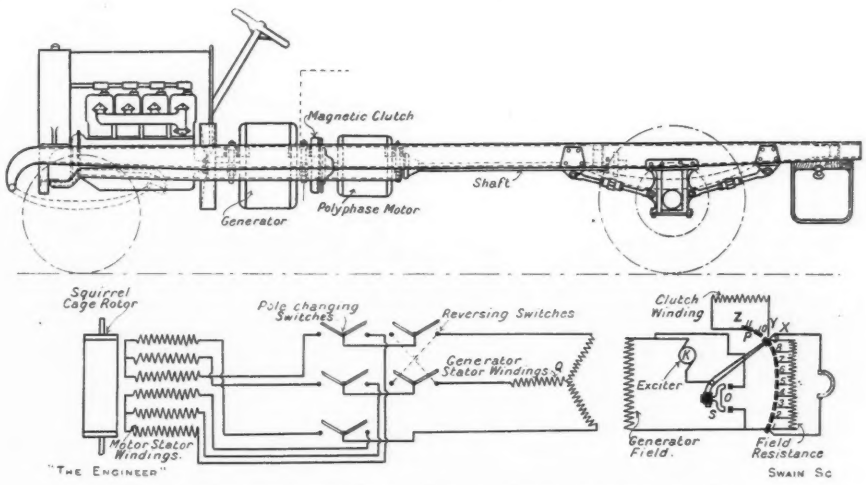


Fig. 40—CONNECTIONS FOR HART-DURTNALL PETROL ELECTRIC OMNIBUS

A very simple petrol-electric omnibus is built by the firm of W. A. Stevens, Limited, of Maidstone. For some time past the Tillings Omnibus Company has been running these vehicles on the London streets, and we are told that they have proved so successful that the company is about to employ the Stevens electric transmission on all its motor omnibuses. The electrical equipment simply consists of a dynamo, a motor, and a reversing switch. No clutch is used, but the dynamo is coupled to the fly-wheel of the engine by means of a flat leaf spring coupling, which allows for any inaccuracy in the alignment of the crank shaft and dynamo armature spindle. The propeller shaft, which is approximately 7ft. long, is coupled to the armature spindle by means of a ball-bearing universal joint, and is connected to the back axle by a sliding toothed joint. The mechanical construction of the vehicle, how-

ever, can fairly well be gathered from the drawing—Fig. 41—and from the illustration—Fig. 39—showing the complete chassis. The controller box, to be seen slung at the side of the chassis, carries a reversing switch and a shunt resistance, the latter being in series with the generator field. The reversing switch is operated by a side lever and the field regulator by a small horizontal lever on the steering wheel column. The generator, which is capable of an output of from 1 to 25 kilowatts, at a speed varying from 350 to 1400 revolutions per minute, at a voltage ranging from 0 to 450, is designed with a falling characteristic curve, so that any increase in the demand for current when the engine is fully loaded is accompanied by a corresponding reduction in the pressure. The output in kilowatts at any speed is proportional to the power exerted by the engine, but the volts and ampères may vary over a large range according to the gradient, speed, or degree of acceleration required. The ampères required by the series-wound motor are nearly proportional to the torque on the cardan shaft, and the speed of the motor is to a less degree proportional to the voltage provided by the dynamo. It follows, therefore, that when the vehicle is running on a level road the demand for ampères is small, but when the vehicle is running up gradients the current increases with a corresponding decrease in voltage, resulting in a slower speed with increased torque. It is to be noted that this change takes places automatically. On level roads and ordinary gradients the whole of the control is effected by the gas throttle pedal, which is operated by the right foot of the driver. On heavy gradients, however, the shunt resistance has to be used to allow of increased engine speed. The controller has three positions—"forward," "neutral," and "reverse"—the whole of the regulation being effected with the controller handle in one position. As the generator loses its excitation at a speed of 300 revolutions per minute, it is not necessary to break the circuit between the dynamo and motor when a stop is necessary, on account of the congested state of the road traffic. It is simply necessary to release the throttle pedal, when the engine slows down, and at a speed of 300 revolutions per minute the generator volts drop to zero, and no power is transmitted to the cardan shaft.

The petrol-electric omnibus as manufactured by the Daimler Company constitutes a good example of the mixed system, for in this instance batteries are used in conjunction with two dynamotors. These latter are simply ordinary dynamos, but since they are also used as motors they have been given the name dynamotors. Under ordinary light running conditions the two engines, which are situated on the two sides of the vehicle, and which transmit their power to the back wheels through the armature shafts, drive the vehicle without any electrical assistance, but at the same time current is put into the battery from the dynamos. If, however, additional power is needed to enable the omnibus to negotiate a gradient the excitation of the dynamos is weakened, which causes them to act as motors, and current is drawn from the battery. One of the 12 horse-power Knight engines and dynamotor units is shown in Fig. 46. Each dynamotor, which is a six-pole shunt-wound machine, is rated at 3 kilowatts, but has a give-and-take capacity of from three to four times this rating. As regards the control, there are two levers placed on the top of the steering wheel. One of these is connected to the two engine throttles, and the other to a rheostat which regulates the excitation of the two dynamotors. When the vehicle is moving in a forward direction the dynamotors are connected in parallel, but when moving in a backward direction they are connected in series. The parallel or series connections are made by means of a lever within easy reach of the driver, but this is only used when a change in the direction of running is required. The automatic changing of the dynamotors from dynamos to motors is governed by a solenoid, which, when the accumulators are fully charged, draws the throttle levers of the carburetters downwards, thus reducing the speed of the petrol motors. As the accumulators discharge, the solenoid gradually loses its magnetic effect, and the throttles then open, thus increasing the speed of the engines and that of the dynamotors, the latter then acting as generators and recharging the accumulators.

The latest development in connection with electric transport in this country is the introduction of the railless trolley system, which provides an inexpensive and convenient method of transit in districts where, for one reason or another, tramways or railways are impracticable. The first railless trolley lines in England were formally opened in Bradford and Leeds on June 20th of the present year. On the Continent, however, a number of lines have been working successfully for some considerable time. In 1903 a short line was opened at Grevenbruck, Westphalia. Within the next two years five other lines were put into operation on the Continent and the list has since been largely increased. Railless trolley omnibuses are now working over many miles of route in Austria, Germany, France, Italy and other countries. In 1909 the Railless Electric Traction Company constructed a short experimental line at the Hendon depôt of the Metropolitan Electric Tramways. A large number of experiments were made on this line, and here the system as used at Leeds and Bradford was developed. The overhead work at Bradford is of similar design to that at Leeds, and in both cases the overhead work was carried out by the Tramway Department. In this system the two wires are placed side by side, and the current is collected and returned to the negative conductor by means of trolley arms. The trolley arm allows the vehicle to run at a radius of 16ft. from the centre of the trolley wires—measured from the centre of the vehicle—and as the roadways do not exceed 31ft. in width ample reach is provided.

The electrical equipment for the omnibuses at Leeds and Bradford was supplied by Siemens Brothers. The vehicles are driven by two motors, each having a capacity of 20 brake horse-power. They are designed for a pressure of 525 volts and a speed of 1050 revolutions per minute, which represents a travelling speed of 10 miles per hour. The motors are series-wound machines, and the field windings are shunted to obtain speed variation. The controllers are of the Siemens parallel magnetic blow-out type.

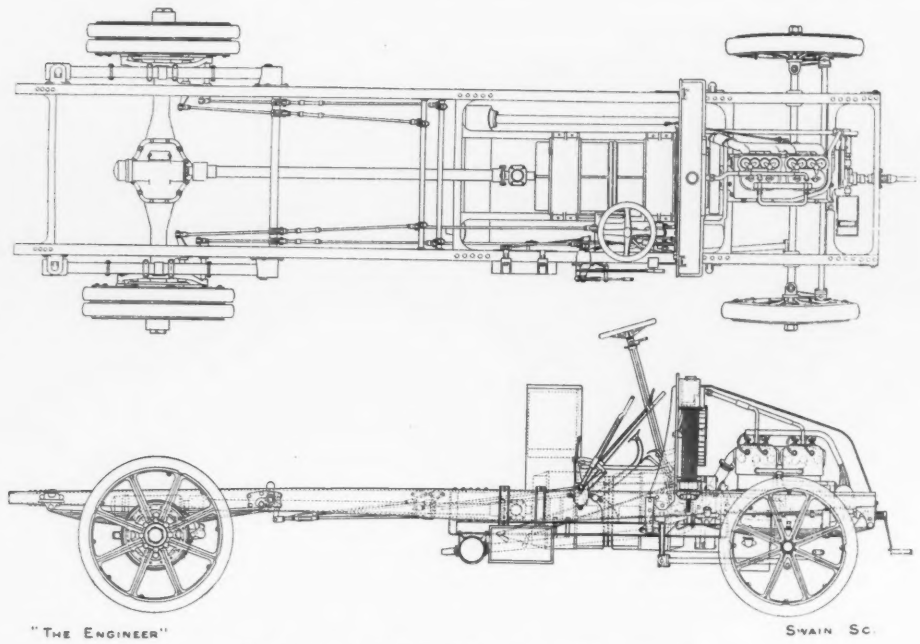


Fig. 41—PLAN AND ELEVATION OF STEVENS CHASSIS

Fig. 42—CURRENT COLLECTOR

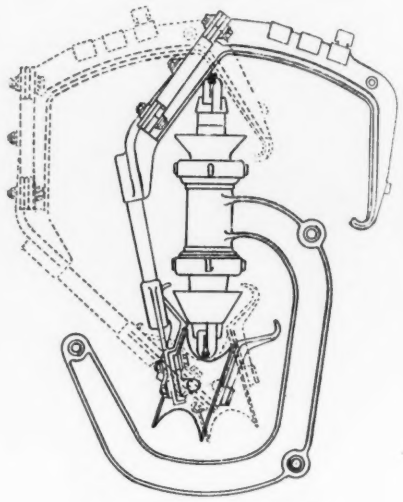


Fig. 44—TROLLEY SUSPENSION

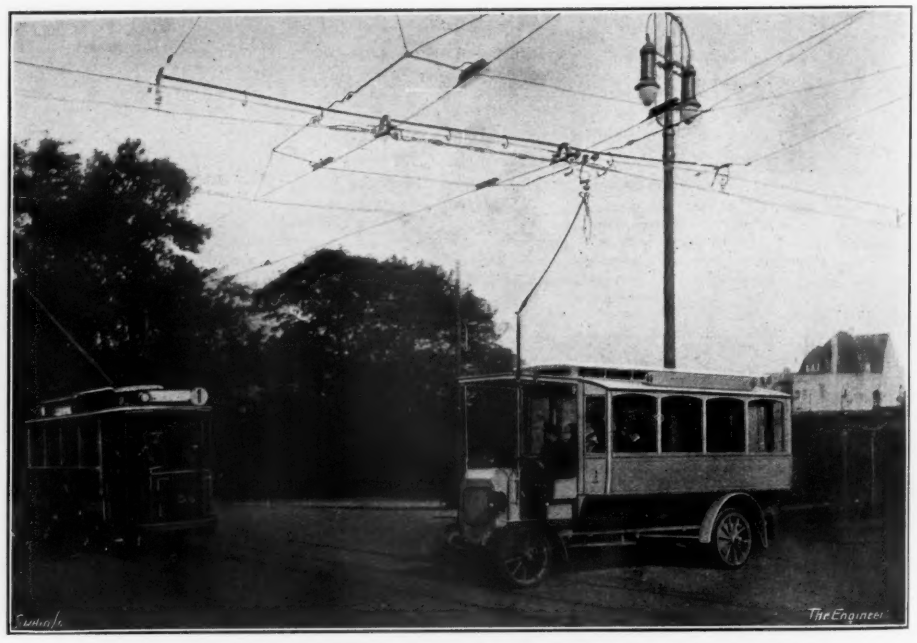


Fig. 43—TROLLEY OMNIBUS CROSSING TRAMWAY

The Brush Electrical Engineering Company, of Loughborough, has recently acquired the patent rights of the Bremen trolley omnibus system. The system is said to be working very satisfactorily on the Continent, and we understand that the Brush Company is about to construct a demonstration line in England. In the Bremen system, as can be seen from Fig. 43, the two wires are one above the other, and the upper negative wire serves to sustain the whole trolley, whilst the lower positive wire makes contact with a sliding bow collector. Below this there is a universal joint in which the trolley is free to turn in any direction. The upper negative wire is earthed at various points along the line, and being above the positive conductor it serves as a guard wire. The sliding bow collector on the lower wire allows of free axial play. Below the swivel joint there is a loop spring arrangement for dealing with shocks arising from uneven road surface. The dotted lines in Fig. 42 show how this loop opens when necessary. The drawing—Fig. 44—shows the extreme positions the trolley wheels and bow may take up. The current collector may oscillate freely within these limits, and it is claimed that it can never leave the wires, nor can the wheels jump on the upper wire, for no room is provided for any movement except from side to side as shown. The illustration—Fig. 43—shows a Bremen trolley omnibus crossing a trolley tramway system.

The Cedes Stoll system has also met with considerable favour on the Continent. Here, again, current is taken from the overhead positive wire and returned to the negative wire by means of flexible cables, the wires in this case, however, being side by side. The head or actual current collector is composed of a frame having two small grooved wheels on each side of it. One of these wheels runs on the positive and the other on the negative wire, and the cable is suspended from the centre of the frame, from which point a weighted pendulum is attached, which keeps the wheels well pressed on the wires. The conducting cable can be lengthened so as to allow it to follow the car by means of two appliances, an upper sliding knot tied to the pendulum weight and stretched by means of a spring in the latter, and a cable roller with ten or twelve yards of cable, which can be rolled up and let out by means of a spiral spring. From the illustration—Fig. 47—it is amply evident that the car can clear all kinds of obstacles and make headway without being hindered by the general traffic. When two cars running in the opposite directions meet the drivers interchange trolley conductors by means of detachable contact boxes. We are told that the car can move as much as 20 yards away from the wire. The illustration—Fig. 45—shows a passenger car with a motor on each wheel, and coupled to a trailer car. It will be gathered that the same type of motor is used on these vehicles as that adopted by the company's first-aid vans, as supplied to the London Fire Brigade. In fact, this motor is employed on all the company's electrically propelled vehicles.

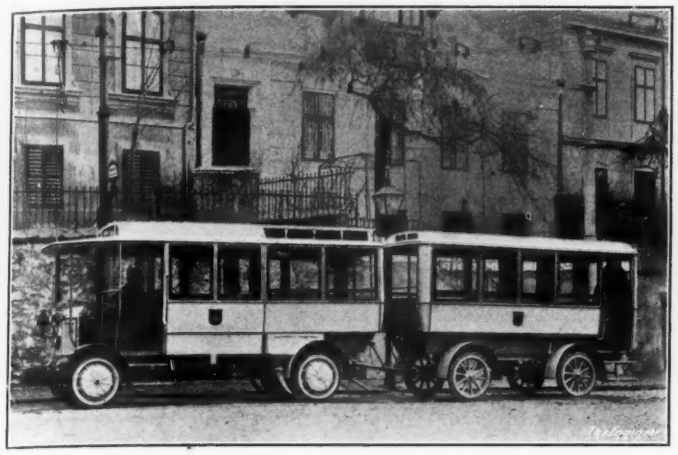


Fig. 45—CEDES TROLLEY MOTOR AND TRAILER CAR

Fig. 47—CEDES TROLLEY OMNIBUS

Fig. 46—DAIMLER POWER UNIT

MINING LOCOMOTIVES.

Comparatively little has been done in this country in the way of using electric locomotives underground, but in the North of England they are largely employed for conveying coal from the pit-head, and notably in the Newcastle district. The Harton Coal Company, for example, which owns various collieries in the neighbourhood of South Shields, possesses two lines of railway between the St. Hilda Colliery and two wharves on the river Tyne, one called the High Staithes and the other the Low Staithes.

Electric traction on the Harton Coal Company's line was commenced in 1908, when one electric locomotive was put into use. That beneficial results were derived from electric working is evident from the fact that up to the end of last year six Siemens electric locomotives were running over these lines, and 7·2 miles of track had been electrified. Many advantages are said to have been derived from the use of electric traction on these lines, but we cannot enter into them all. It may be mentioned, however, that the working expenses are said to be much reduced, first on account of the reduction in wages, due to the fact that with each electric locomotive two men are employed, one driver and one pointsman, whereas three men were needed for each steam locomotive, namely, one driver, one stoker, and one pointsman. Secondly, the electric locomotives do not take energy from the line unless it is actually at work, whereas coal is continuously being burned in a steam locomotive while it is standing. The locomotives are of the direct-current type, and are supplied with current through a motor generator at a pressure of 550 volts from the Newcastle Electric Supply Company. Current is fed into the locomotives from an overhead wire, as the use of a third rail in the shunting yards was found impracticable. The Siemens bow collector, with its advantages for shunting operations, has been adopted. Of the first six locomotives supplied two are of the two-axle type, two of the ordinary two-bogie, whilst the other two are articulated locomotives.

The illustration, Fig. 49, shows a special type of locomotive built by Siemens Brothers for colliery service in the Newcastle district. This is a 20-ton bogie locomotive specially designed for a narrow-gauge track, namely, 2ft. 2in. The motors of each bogie, which are 88 horse-power 500-volt machines, are placed in the centres of the bogies and above the level of the axles.

Fig. 48—UNDERGROUND MINING LOCOMOTIVE

In order to meet the conditions usually prevailing underground the locomotives have to be very compact, and also of robust construction. The illustration, Fig. 48, shows an underground locomotive built by Siemens-Schuckert, which is at work in a mine in Germany. Where the lines are long and the output considerable, telephone installations are sometimes provided, so that the drivers can communicate with the surface in the case of breakdown or accident. The telephones may be carried on the locomotives and connected to the wires in the gallery when necessary. The firm of Siemens-Schuckert appears to have constructed a large number of locomotives for underground working in Germany, some of which collect the current from overhead wires, whilst others derive their current from storage batteries. When the former practice is adopted, the above-mentioned firm advocates continuous-current working at a pressure of from 220 to 250 volts. Higher voltages, it is maintained, can only be used when the galleries are sufficiently lofty to permit of the trolley wires being fixed out of reach, or when the roads are not used by the men. Accumulator locomotives render valuable service where the galleries are very low, and also as feeder locomotives for main lines.

In underground haulage, practice on the Continent has been developed along lines different from ours, and similar to the American system. There, except on inclines, a haulage rope is rarely seen. The use of locomotives is almost universal; they are operated by petrol, benzine, or compressed air, and in open lamp pits sometimes by electricity from trolley wires. The difference in

practice is interesting, and it is not accounted for by difference in the mining conditions, but rather by the personal predilections of the officials.

OVERHEAD TRANSPORTERS.

In all the systems of electric traction so far considered the vehicles either run on rails or on the road bed. In 1881, however, the late Professor Fleeming Jenkin devised a system of electric locomotion in which the vehicles are hung upon a line composed of a strong steel wire cable, and to this system he gave the name "telpherage." The first line, which is shown in Fig. 51, was erected in 1885 on Lord Hampden's estate in Glynde, in Sussex. The system was introduced for the transportation of goods in localities where the traffic would be insufficient to support an ordinary railway. The line may be rigid, and in this case a high speed of transit may be attained. The motor hangs below the line, and transmits the power to the driving wheels either through gear wheels or a chain.

A great many overhead transporters are now in use, and there is not the least doubt that the system often presents considerable advantage. The transporters can be equipped with lifting gear, so that the material may be raised from the ground level in buckets or skips, so as to clear all obstructions. The drawing, Fig. 52, shows a Telpher of the bogie type, as manufactured by the firm of Strachan and Henshaw, Limited, of Bristol. It will be gathered that the current is collected from two overhead wires, which are placed above the girder on which the transporter is supported. It will also be noted that there are two motors, one for lifting and the other for travelling, and that this particular transporter is provided with a grab suitable for handling coal.

Electric telpherage conveying plants have been manufactured by this firm for many classes of service, and various designs have been got out to meet different conditions of working. At the Birmingham Corporation Gasworks the firm has erected a telpher for dealing with hot coke. The coke is received in lattice skips and conveyed through either end of the retort-house to the quenching tank. It is then carried to the storage yard, where it is tipped at any desired height above the ground level, depending upon the height of the coke heap. Shallow skips are provided in cases where the clearance is exceptionally small between the bottom row of retorts and the floor. A special type of transporter is manufactured for heavy and continuous duty, and the firm also builds electric telpherage conveying plants to work on a cable track.

Fig. 53 shows a two-motor transporter built by Royce, Limited, for running on the bottom flange of a rolled steel joist. These transporters are either carried from four cast steel single-flanged runner wheels, or suspended from two swivelling bogies each carrying four cast steel runner wheels for travelling on a curved track. A transporter of the latter type is shown in Fig. 53. In both cases a cage for the operator and control gear is fixed at one end of the framework. The hoisting barrel is driven from the motor through a train of spur gearing. A solenoid brake with an oil dashpot is fitted to the hoisting spindle, and is arranged to come into operation automatically when the current is interrupted, and to be released when the motor is re-started. The travelling motor is operated by a separate motor, two of the trolley wheels being driven through a train of gearing. A special feature of these transporters is the overwinding safeguard, which consists of a slipper wheel device together with a stop fixed on the under side of the transporter framework. When the lifting block comes up against this stop the wheel slips, thus preventing damage to the motor and gearing. The device also prevents the transporter from lifting greater loads than those for which it has been designed. Transporters of this description are designed for working in the open, when the driver's cabin is housed in, and the motor and gearing are also protected.

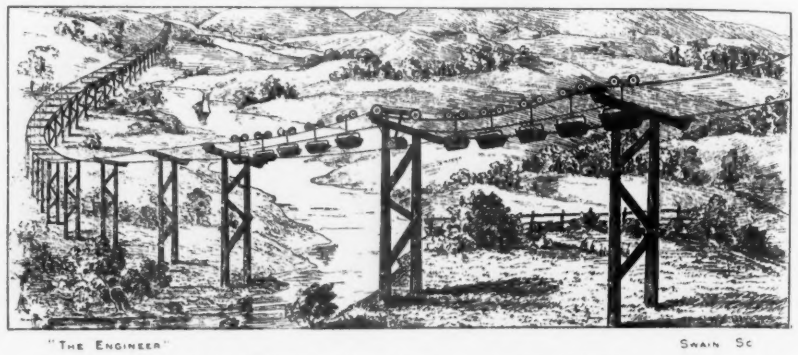


Fig. 51—THE FIRST TELPHER LINE AT GLYNDE, SUSSEX

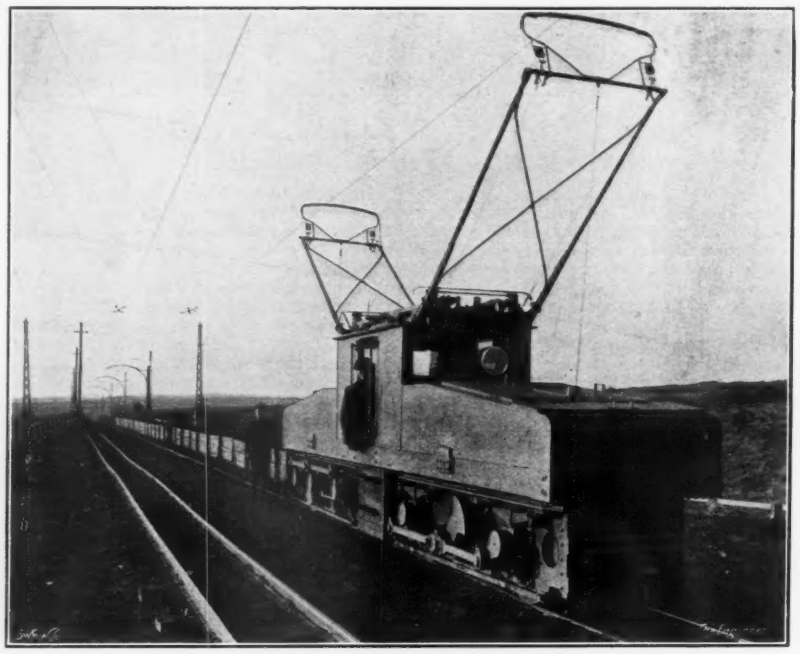


Fig. 49—SURFACE MINING LOCOMOTIVE

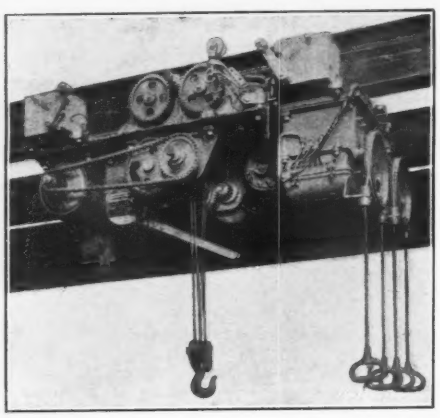


Fig. 50—MONO-RAIL HOIST

A mono-rail hoist as manufactured by the Witton-Kramer Tool and Hoist Company, of Witton, Birmingham, is shown in Figs. 50 and 55. In this particular instance the operator controls the machine by means of pendant cords operated from the floor level. It should be mentioned, however, that this firm adopts two other systems of control. In one instance the switchgear is mounted on a wall or in any other suitable position, and in the other instance controllers are fitted in a cage in which a seat for the operator is provided. Travelling hoists are also manufactured by this firm in which only the lifting operation is carried out electrically, the travelling being effected by pushing the machine along the underflange of an I section girder. The general design of the hoisting gear, however, is the same in each case.

ELECTRICALLY-PROPELLED BOATS AND SHIPS.

It has been shown that the idea of employing electricity for the propulsion of boats dates back to the year 1838, when Professor Jacobi built his electrical boat, which was propelled with primary batteries on the river Neva. It seems that Professor Jacobi first used Daniel cells, but afterwards found that very much better results could be obtained with Grove's cells. It was not until the advent of the storage battery, however, that a successful electrically-propelled boat was produced. Electric launches worked with storage batteries have met with prominence in many quarters, and notably on the river Thames, where there are many charging stations. Of late years, however, the petrol engine has been largely adopted in this connection, and the progress of electric launches has suffered in consequence. In 1888 Professor Forbes predicted the rapid extinction of the steam launch on the Thames, and pointed out that energy for storing in the accumulators of electric boats might be obtained from the waste water going over the weirs. Whilst the number of steam launches has been materially reduced, however, it cannot be said that this has been brought about by the use of electricity, although such might have been the case had it not been for the advent of the petrol engine.

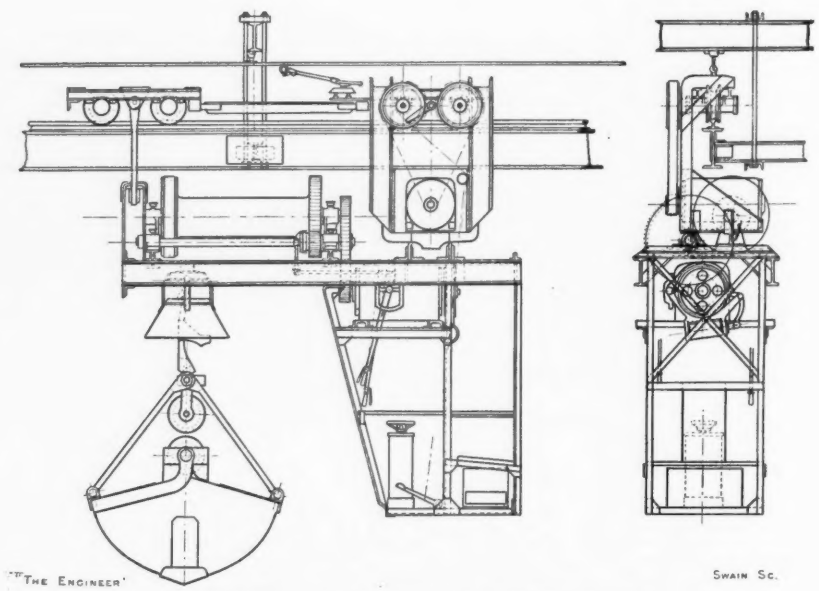


Fig. 52—STRACHAN AND HENSHAW'S ELECTRIC TELPHER

Perhaps the principal difficulty met with by the early electric launch owners was the high price charged for current, which in many cases seems to have been due to the use of resistances to lower the pressure to a suitable value for charging the batteries.

In view of the fact that electric transmission gear has been used on locomotives and road vehicles, it is not surprising that attempts are being made to introduce it for marine propulsion. The need for electric transmission between the prime mover and propeller arises when the properties of the propeller in respect to the rate of revolution are incomparable with those of the prime mover. The crux of the problem lies in the fact that high efficiency is associated with low rate of revolution of the propeller, whilst in the case of the steam turbine, which is now largely used for the propulsion of ships, a high rate of revolution is necessary to obtain the most economical use of steam. The speeds at which internal combustion engines are operated are nearer those of steam engines than the speeds adopted with turbines, but there is a tendency to work with a higher number of revolutions than is desirable for the economical performance of the propeller. Various mechanical means have been devised for giving a speed reduction between the prime mover and the propeller, but these cannot be considered in the present instance.

Briefly stated, the claims made for the electrical system are:—(A) It provides a ready means of reversing the direction of rotation of the propeller without changing the direction of rotation of the prime mover; (B) electrical transmission provides a means for changing the speed ratio between the generator and propeller; and (C) it enables the power of one or more engines to be applied to one or more propellers, so that the prime movers may be used to the best advantage under all conditions, and the highest efficiency can so be secured. In other words, when little power is required one or more of the prime movers can be stopped. Many electrical schemes have been suggested for securing these advantages, but at the present time systems in which polyphase current is used are most prominent. A scheme patented by Mr. W. P. Durtnall is shown diagrammatically in Fig. 56. By way of example, a four-pole polyphase generator is shown on the left, and in the middle a machine for changing the periodicity and voltage, whilst on the right there is a 40-pole squirrel-cage motor, which is coupled to the propeller. The machine in the middle may be looked upon as a slip ring induction motor with twelve stator poles and having a 12-pole star-connected rotor winding. Since we have assumed that there are ten times as many poles on the stator of the motor as there are on the generator, when the connections are made in the manner indicated the reduction in speed between the generator and motor is in the ratio of 10 to 1. That is to say, the propeller speed is twice that which is obtained when the motor is fed direct from the generator. If we interchange two of the generator leads leading to the slip rings G, so that the field in the rotor of the periodicity changer revolves in the same direction as the shaft, we must then add the speed of rotation of the shaft to that of the field instead of subtracting it as before, which means that the periodicity of the voltage at the motor terminals is four times as great as when the generator, is directly connected to the motor, and this means that the propeller will revolve four times as fast as in the first instance. In order that the connections on the controller may be made without arcing, Mr. Durtnall adopts the plan of short-circuiting the series winding of the exciter at the instant when the changes in the connections are made. Mr. Durtnall also claims that he can obtain an intermediate speed by feeding the exciter current in at the slip rings G, so that the middle machine serves as the generator with twelve poles.

Although much discussion has taken place concerning the merits and demerits of electric transmission for ships, there is only one firm in the United Kingdom which has put the scheme to the test of practical application, and this is Mavor and Coulson, Limited, of Mile End, Glasgow. The small vessel which this firm has equipped with electric transmission gear, and which has been named the Electric Arc, is illustrated in Fig. 59, whilst Figs. 57 and 58 show the engine and electrical machinery. The principal dimensions of the vessel are 50ft. by 12ft. by 7ft. 4in. The engine, which is of the internal combustion type, drives a three-phase generator at a speed of 800 revolutions per minute, but the speed can be reduced by the throttle. There are two windings incorporated in the same generator, so that the machine is capable of giving two periodicities corresponding to four and six poles. The current is led to a motor, which also has two windings, one for eight poles and the other for twelve poles. The generator and motor windings are shown diagrammatically in Fig. 54, the connections, as shown at the top of the diagram, being for full speed working, and those at the bottom of the diagram for two-thirds speed.

On May 31st of the present year a special trial run was made with the object of demonstrating the advantages derived from the system. On this occasion the vessel ran a double course on the measured mile, the mean speed attained being 7¼ knots, equal to 8⅓ miles per hour. Demonstrations in rapid manœuvring proved that the time required to stop the vessel from full speed ahead was 23 seconds. A comparison of the actual results attained with those of ordinary practice are interesting. The builders' estimate of results on lines of ordinary practice are as follows:—Engine power required, 45 horse-power; propeller revolutions, 750; speed of vessel, eight miles per hour, whilst the actual results attained with electric transmission are: engine power, 35 horse-power; engine speed, 800 revolutions per minute; propeller speed, 400 revolutions per minute; mean speed on measured mile, 8⅓ miles per hour. From the foregoing it will be observed that, making proper allowance for inaccuracy in judging, the power required in the first

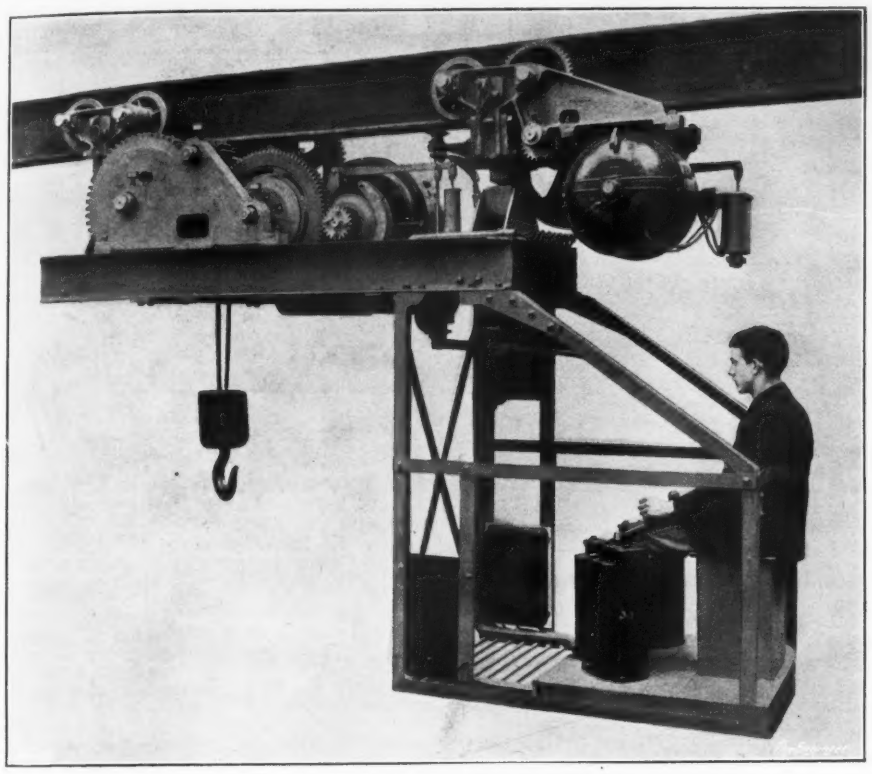


Fig. 53—ROYCE TRANSPORTER

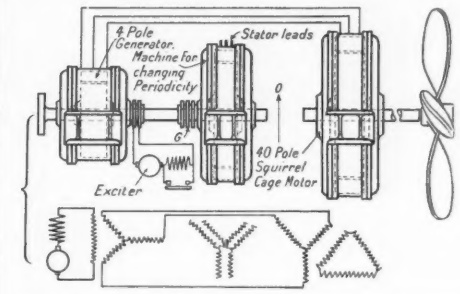


Fig. 56—DURTNALL'S MARINE TRANSMISSION SCHEME

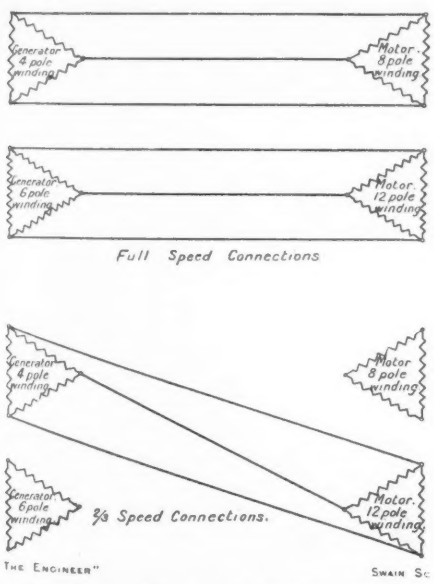


Fig. 54—CONNECTIONS FOR THE ELECTRIC ARC

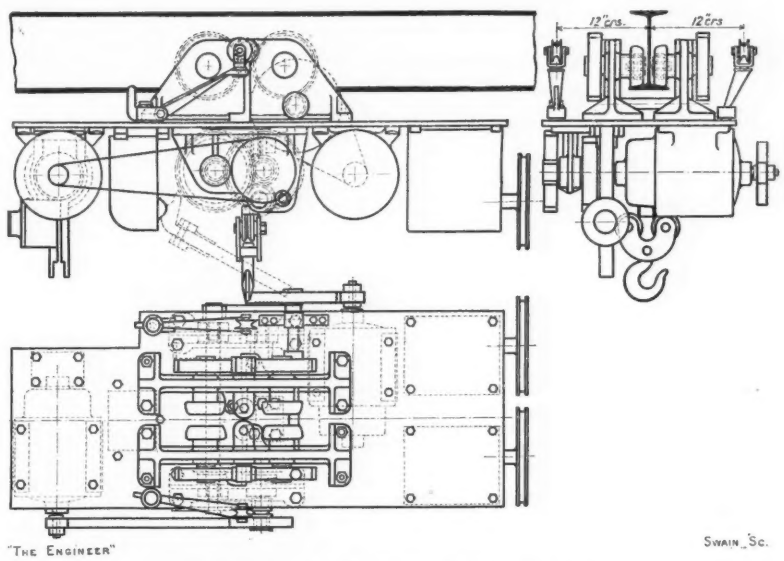


Fig. 55—PLAN AND ELEVATION OF MONO-RAIL HOIST

instance, the losses in electrical transmission are fully compensated by the increase in propeller efficiency. The actual shaft horse-power obtained at the time of this trial was 24.7. Previous tests showed that the electrical efficiency of the transmission gear was 70 per cent., and on this basis the 35 brake horse-power for the engine was estimated. It is worthy of mention that at the time of this trial run the controller handle was rapidly turned from the full speed ahead position to that corresponding to full speed astern, thus giving rise to conditions of a more severe character than would be obtained by short-circuiting the plant.

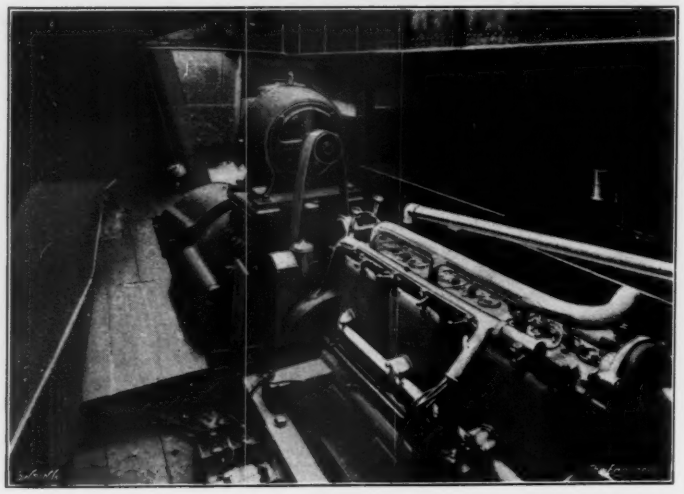


Fig. 57—ENGINE END

Fig. 58—GENERATOR END

At the last annual meeting of the British Association Mr. A. H. Mavor read a paper on this subject, in which he gave particulars of several vessels now being fitted with electrical transmission gear. One vessel he described is the turbo-electric steamship Frieda, which is being built for American owners, and which has been specially designed for the transport of bulk freights between the Gulf of Mexico and New York City. The vessel is to be 300ft. long, and is to carry a dead weight of approximately 5000 tons at a mean loaded speed of 12 knots at sea. The propelling machinery will consist of a turbo-electric outfit, giving three-phase current at a periodicity of 50 cycles per second when running at a speed of 3000 revolutions per minute. The motor, which is to be directly coupled to the propeller shaft, is to develop 1900 brake horse-power at a speed of 84 revolutions per minute. Mr. Mavor stated that the installation would cost and weigh less than the normal equipment, and the saving in coal would be over 10 tons per day. Another example brought forward was an oil electric tank barge for Canadian service. In this case the equipment consists of three separate non-reversing Diesel oil engines, each capable of developing 200 shaft horse-power, and directly connected to an alternating current generator. The currents from one or all the units are led to the separate windings of a three-phase motor directly coupled to a single slow-turning screw. A marine turbo-electric scheme has also been submitted to the United States Navy Department for adoption in one of the four large colliers recently given out for contract. In this case it is proposed to use a 5000-kilowatt turbo-alternator with condensing plant, the current being led to two motors, one for each propeller shaft. The vessels in which it is proposed to use this equipment are to be 525ft. long, and are to carry a dead weight of 12,500 tons of coal at a speed of 14 knots at sea. Here again it is claimed that the electrical equipment will give rise to lower cost and weight, and higher efficiency, than could be obtained with the usual reciprocating equipment.

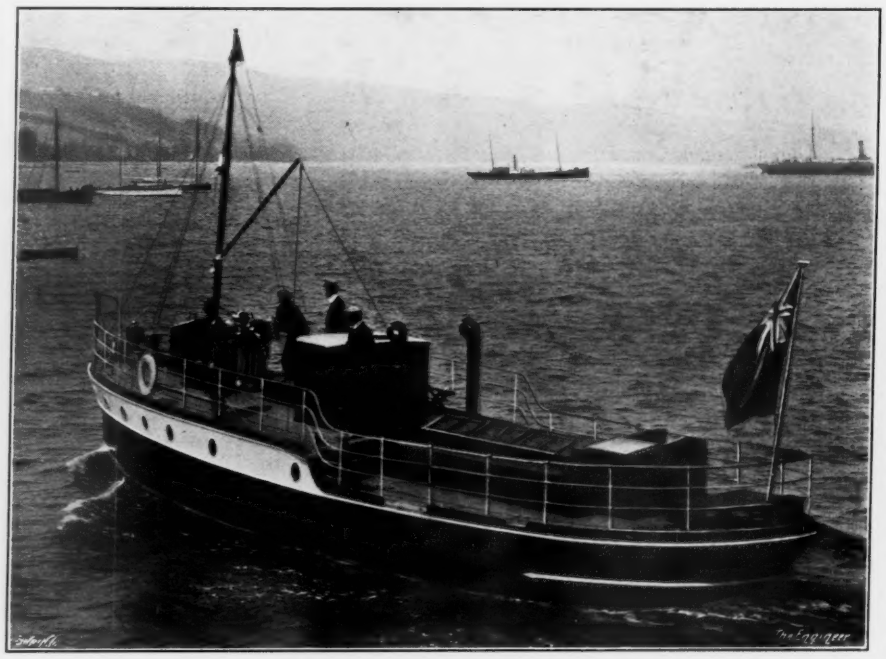


Fig. 59—THE ELECTRIC ARC

It is maintained in certain quarters that there is no field for electrical transmission gear in vessels of such large size as the Lusitania. Mr. W. P. Durtnall, however, contends that such a conclusion is totally erroneous, and he has recently got out a scheme which he maintains, if applied to the Lusitania, would result in a considerable improvement in the performance of that vessel. Although the saving in weight of plant is not material, the saving in coal and wages is shown to be considerable. Mr. Durtnall points out that since the electrical plant gives rise to a lower fuel consumption, the difference in the weight of coal to be carried has to be considered. He estimates that for five days' steaming the electrical boat would only require 3180 tons of coal for propulsion. This he maintains means a saving in weight to be carried, as compared with the present conditions, of 1230 tons. He also points out that this gives rise to a great saving in space, and the carrying capacity of the vessel would be increased in consequence. Although little has been done in the United Kingdom in the way of putting marine electric transmission schemes to the test of practical application, there is evidence to show that many of the large electrical engineering firms are taking keen interest in this new development, and during the last few years many patents have been taken out relating to marine electrical schemes. Some curious arguments have been put forward by those who are opposed to the system, one of the most remarkable being that it would necessitate carrying a staff of well-trained electrical engineers. This is a particularly curious statement when it is remembered that many marine engineers are now in charge of some of the largest electric light and power stations.

In this Supplement an endeavour has been made to trace the development of electric transport, and to place on record some of the most noteworthy advances made in recent years. The work that has been done in the direction of utilising electricity in connection with locomotion is enormous, and great credit is due to the pioneer workers in the field. It is somewhat remarkable, however, that in the history of electric traction we meet few outstanding names, whereas in the case of the steam railway Watt and Stephenson are known as pioneer workers in all parts of the world. It is probable that a great portion of the community attribute the introduction of electric traction to the efforts of Edison, but if we endeavour to find a man who deserves to occupy the same position as Watt and Stephenson, we can only conclude that it is Werner von Siemens.

NOVEMBER.

The Railways and London Traffic.

SOMEWHAT late in the day the North-Western has discovered that it has a suburban traffic of no little value. Having thrown off its lethargy and descended into the arena to serve democracy, it intends to do so with no half measures. The scheme includes the electrification of the Watford widened lines, of the North London from Broad-street to Chalk Farm, the Hampstead Junction Railway, and the North and South-Western Junction Railway. But the most interesting is a proposed through service, in specially built coaches, by means of a physical connection with the Baker-street and Waterloo Railway, between Watford and Paddington, Marylebone, Charing-cross, and Waterloo. When the N. and S.W.J. line is electrified, the North London service can be extended to Hounslow and Ealing also, because electrical trains can run on to the District at South Acton. That this will be done is most certain, as the Central London, which will shortly have its eastern terminus also at Broad street, obtained powers this session to extend its western end to join a line from Ealing to Shepherd's Bush, now being built by the Great Western. There is also a possibility of competition from the Metropolitan, as it hopes to get to Ealing. As a result of a parliamentary bargain made last March, when the Central London got its extension, the Metropolitan has given notice of a Bill to make a curve between the Hammersmith and City Railway and the Ealing and Shepherd's Bush. Simultaneously with the announcement as to the North-Western's intentions as to Watford, comes the announcement that the Metropolitan and Great Central Companies are jointly seeking powers to build a branch to Watford from the Metropolitan main line at Rickmansworth, and that the former company's electrical operations, now terminating at Harrow, will be extended to Watford. A reverse curve at Rickmansworth will give an alternative direct route northwards from Watford. Powers are being sought in the Great Eastern Bill for the East London Railway to be electrified by the lessees, and then the through service between the Metropolitan and District Railways and New Cross can be revived. The South-Western widening between Studland-road and Turnham Green is practically completed, and this will facilitate the District services west of Hammersmith, the trains to and from Wimbledon—and Sutton later—receiving benefit from the proposed widening of the L. and S.W. line between East Putney and Wimbledon. The London Electric Railways Company proposes to take over the Edgware and Hampstead, and to proceed with the construction of that railway. The question of London traffic is therefore receiving excellent treatment at the hands of the railways.

The Institution of Electrical Engineers.

A GREAT deal of discussion has been going on during the month regarding some suggested alterations in the Articles of Association of the Institution of Electrical Engineers. The proposals are the outcome of the labours of a committee nominated some two years ago to consider what alterations, if any, were required in these articles. Broadly speaking, the principal alterations which have been mooted are the three following. There are others, but they are of comparatively minor importance, and as we have dealt with them in a previous issue, we need not go into them again. The three suggested changes are (1) the founding of a class of members to be called licentiates, to which corporate rights will not belong; (2) the institution of examinations for members seeking election or transference to the class of associate members; and (3) the increase all round of subscriptions. These proposals have met with much adverse criticism, both among London members and in the local sections in the country. Special meetings have been called to discuss them, and at some of these members of Council have attended. The proposals as they now stand would appear to involve very radical changes, and it is not surprising that they are not accepted in their entirety by the bulk of the members. But it hardly seems that the occasion calls for acrimonious attacks on the Council. To serve as members of council of any institution is a thankless task at best, and it is hard that those who do take the burden upon them should be hauled over the coals for making, in all good faith, suggestions which they believe are for the good of the great body of members. No doubt in time a solution of the difficulty will be arrived at, and meanwhile it would certainly appear to be best to leave personal feeling out of the matter.

The Railway Dispute.

IF the brief debate on the Royal Commissioners' report on the Railway Conciliation Boards, which took place on the 22nd of the month, has not made much apparent difference in the state of affairs, it has at least made it doubly impossible for the Government to show active sympathy with the recalcitrant men. It had already, in private negotiations, made it clear that it intended to support its own Commission, but in the debate in question the amendment proposed by Mr. Lloyd George and approved by the House gave the last blow to the hopes of the Labour Party. Mr. Ramsay Macdonald endeavoured to persuade the Government to exercise its good offices to bring the employers and the unions together, nominally to discuss the report, but really to reopen the whole question. It was a ruse to get in the thin end of the wedge of recognition. The Government refused to do anything of the sort. It would not hear of the companies being drawn into a long argument on all sorts of details, and consented only to use its influence to bring the parties together on the strict understanding that the only subject to be discussed was the best way of putting the Royal Commission's recommendations into force. This, of course, involves the endorsement of the report by both parties, and we are still waiting to see whether the men are prepared to take that step. If they do not, the report will be a dead letter. After the hurry they were in to get the Commissioners' opinions, it is interesting to observe how dilatory they are in adopting it!

The Royal Commission on Sewage Disposal.

THE Royal Commission on Sewage Disposal has not yet finished its labours. It has just issued another report—the seventh—and it will certainly have to publish one other, if not more. The present Blue-book contains first of all the minutes of evidence on the treatment of trade effluents, but no pronouncement on them, and secondly, some reports on the preliminary treatment of sewage in slate beds. The slate bed, it may be explained, is a tank in which tiers of slates are laid horizontally one above the other, separated at a vertical distance apart of about 2½in. by blocks of the same material. These beds were introduced some time ago by Mr. W. J. Dibdin, who claimed that crude sewage could be to some extent purified on them, and that the sludge could be periodically flushed out with water. The general trend of the reports is that beds such as these should be regarded more as primary settling or septic tanks than as contact beds, the effluent from them being for practical purposes indistinguishable from a tank effluent. Subsequent single contact, it is stated, is not sufficient to produce a satisfactory final effluent with an originally strong sewage, though a non-putrescible effluent can be obtained with one percolating filter in the case of an originally weak sewage. This type of bed certainly possesses one good feature. The sludge it produces is nearly odourless, and if run off each day and allowed to dry it gives rise to practically no nusiance. It is even said that if all the slates are removed from a bed the smell in it is no worse than that in a damp cellar. The Commissioners think that on this account the process is deserving of consideration in those cases in which reduction of smell at a sewage installation is of primary importance.

The State Control of Railways.

AFTER the great railway strike in France the Socialist party in the Chamber of Deputies succeeded in getting through a motion requiring the companies to reinstate all the men who were discharged for failing to return to work within a stipulated period. To give force to this motion the Government backed it up with a threat that, if the companies refused to fall in with the views of the Chamber, measures would be considered for bringing the direction under the control of the State. This is obviously one reason for the Bill which has just been introduced whereby the directors and the chief engineers of the principal services are to be appointed by Government for a period of six years. It further provides that the system of taking on men, their promotion, the scale of wages, pensions and fines, as well as the measures of discipline, are to be approved by Government. In a word, the companies are to have no control whatever over the staff and the railwaymen, who are to be amenable to the State, if the Bill is passed, exactly in the same way as if the railways were State-owned. This is, in fact, the principal aim of the Socialists. After the experience of the Ouest-Etat they do not dare openly to advocate the taking over of the railways. The method they propose is much more convenient, since the companies would still have the responsibility and the State would have all the control, and thus the Socialist aim would be attained without cost to the ratepayers. As the companies have never been able to make alterations in fares or time-tables, or carry out works of any kind without the approval of the Minister of Public Works, their independence has been limited to the administrative and executive control, and in this matter they have stood firmly against outside interference; but if the new Bill is passed this independence will be utterly lost. The companies have entered a very strong protest against such a measure, which, they say, experience has shown would be the end of all discipline, for the companies have never suffered so severely from strikes as have the Ouest-Etat and the postal service, where the same organisation is at work that the Bill proposes to enforce upon the companies. Should the Chamber of Deputies be so ill-advised as to pass the Bill, the results will be disastrous, and the shareholders will clear out as fast as they can, which is perhaps what the Socialists desire. For the moment the future of the French railways is not reassuring.

Island Barn Reservoir.

WITH considerable pomp and cermony—Lord Mayors and Mayors attending in official robes—the Island Barn reservoir of the Metropolitan Water Board was formally declared open on the 4th of the month by Sir T. Vezey Strong, the then Lord Mayor of London. This, the latest unit added to the storage capacity available for the use of the metropolis, will increase that capacity by something like 900 million gallons. It is a fine piece of work, though it presents no radically new departure in reservoir construction. The Thames Valley does not lend itself to the holding up of large bodies of water by the construction of dams, and all its reservoirs are formed in the same manner, that is to say, by means of a puddle wall carefully dovetailed into the virgin London clay, these walls being protected and held up on both sides by sloping embankments. In some cases more levelling of the ground surface is required than in others. The Island Barn site probably exhibited about an average amount of excavation, being very fairly flat. The actual water surface when the reservoir is at its full depth will be 121 acres, the length of the embankment enclosing it being approximately 1⅝ miles. Quite a feature of the work is the inlet weir. This consists of a wide stone staircase. The water is pumped into a basin at the top of the embankment, and, overflowing the edge of this, falls in a cascade down the stairs, being, of course, considerably aërated as it does so. It may be added that this reservoir was originally projected by the late Lambeth Water Company, and had the Water Board not been created this additional storage would probably have been available some seven years ago.

Another State Railway Disaster.

THE disaster to a train near Montreuil-Bellay last week has once more aroused strong criticism against the management of the State railways. A train, with two locomotives attached, was crossing the Thouet valley when the bridge collapsed and the train fell into the river, which was swollen to a torrent. It is unknown how many lives were lost, for the violent currents have rendered search very difficult. The only passengers saved were a few who managed to climb on to the side of a carriage emerging from the water, where they remained throughout the day. Others escaped through the coupling breaking and leaving two or three carriages on the embankment. The Thouet is a small river flowing through a valley, and is traversed by an iron bridge supported on a central stone pier and stone abutments, to which there is an approach on either side by high embankments. At times the Thouet is swollen by a tributary which comes down in a freshet, and at the time of the accident the water had risen to a greater height than had been recorded for many years. While the train was passing over the bridge the stone pier collapsed, and the metallic superstructure swung round and turned over. At first it was supposed that the currents had sapped the base of the pier which fell down bodily, but the divers assert that the pier is broken off about 5ft. from the base. This strengthens the opinion of many who declare that the Thouet bridge has for years been known to be weak. Being originally constructed for light local traffic it has since been used for much heavier trains, and it is affirmed that the bridge, which was built in 1872, was in anything but good condition of repair. Whatever ground there may be for these criticisms it is certain that this disaster has further weakened the position of the State railway department, which is accused of negligence in not ensuring the safe working of the lines.

Employers and Strikes.

JUST as the mechanics' strike of 1896 7 led to the formation of the Employers' Federation, so the recent disturbances are leading to new amalgamations of employers to combat the trades unions. Two have certainly been established during the month, and others are still in the air. Of the two formed, that called the Trades Disputes Act Reform League is perhaps the most important, although its field of action is more constricted than that of the other, which is known as the London Employers Federation. The Reform League, as its name implies, has been established with the sole object of bringing about a change in the law of 1906, which permits picketing, and which has been fruitful in prolonging and embittering strikes. Lord Claud Hamilton has accepted the presidency, and on November 14th issued a statement

in which he said that it would be the endeavour of the League to convince Parliament that "a mistaken effort of legislation which threaten the safety of life, liberty, and property must be amended," and to conduct "an educational movement regarding the dangerous powers which Labour agitators are able to wield owing to the Trades Disputes Act." The London Employers Federation is, it is understood, unlike the Reform League, to be a purely defensive body, but until the first general meeting has been held in January we shall not know precisely what its functions are.

The Fatigue of Metals.

Since 1871, when Wöhler first published the results of his elaborate and painstaking investigations on the endurance of metal, engineers and physicists have alike endeavoured to extend his work and to draw some explanation from his and their own results for the curious phenomenon which goes by the name of fatigue. The paper recently read and discussed before the Institution of Mechanical Engineers, descriptive of some endurance experiments undertaken at London University College, can hardly be called brilliant by reason of the results actually achieved. Nor will the discussion, interesting although it was in many places, be found to offer the clarity of thought which most engineers desire to possess on this important subject. Indeed, paper and discussion alike have only further confused the average engineer. Professor Arnold, in his remarks during the discussion, has severely shaken the faith which engineers have been accustomed to repose in the Wöhler test. His statement that the Wöhler test fails to condemn brittle material is admitted to be correct by many who have practical acquaintance with the subject. But it has been urged that the Wöhler test is not, and never has been, put forward as a test for brittleness, and is solely a test for endurance. Absurd as it may seem, it is now certain that a specimen, highly satisfactory as regards its resistance to fatigue, may be highly unsatisfactory by reason of its brittleness. Brittleness is difficult to define; it is still more difficult to measure. But it is abundantly clear that the complete test of a constructional material must involve an examination both of its fatigue-resisting properties and its brittleness. Either by itself will convey quite a wrong impression of the suitability of the material for the given purpose. It is obvious then that, could we devise a machine which in a single operation would measure both these qualities, and which would discriminate correctly between their relative importance, we would be taking a real step forward in this matter—probably the first since Wöhler's time.

Aeroplanes in the French Army.

The report upon the War Estimates which are to come up for discussion shortly in the Chamber of Deputies gives special prominence to the value of the aeroplane for military purposes. The amount asked for is 7,600,000f., making a total of about 15,000,000f. devoted to the aviation service during the past four years. The number of aeroplanes at present owned and under order by the War Department is 174, while negotiations are in progress for the purchase of several others. Pilots are recruited from all branches of the service, and have to pass through four periods of instruction and training, the first being a theoretical instruction in the aeronautical corps, lasting from two to three months, followed by practical instruction in one of the aviation centres, where they have to obtain a certificate of capacity from the Aero Club. There are at present 150 officers holding certificates qualifying them to pilot aeroplanes. The third period of instruction consists in perfecting those pilots who have already shown special aptitude for aviation work, and every year certificates are awarded to those who come successfully out of the ordeal by the General Inspector of the Military Aeronautical Department. The men thus selected complete the fourth period, consisting of a progressive method of training, whereby they get accustomed to making long flights, and are instructed in the tactical and strategical uses of the aeroplane. There are fifty officers fully qualified to pilot aeroplanes in warfare, and a hundred pupils. Extensive tests carried out during the past year have shown that the aeroplane allows of perfect observation from a height of 600 m. to 800 m., where it is beyond reach of artillery, and in the course of an hour or two it can cover the entire front of an enemy and indicate the exact positions at headquarters. For this purpose, however, the aeroplane must carry an observer in addition to the pilot, and the observers themselves are carefully selected on account of their experience, judgment, and tactical knowledge. So long as the aeroplane remains in a state of evolution the French Government has not abandoned the dirigible balloon, which is found to render good service for night observations, and at the end of 1912 the French army will own eleven dirigible balloons, all of them of the non-rigid type, and sufficiently small to allow of their being easily manœuvred and transported.

The Ouest-Etat Again.

Those who voted the purchase of the Ouest Railway by the State have little reason to congratulate themselves on having effected a good business transaction. Since the railway has been taken over it has been a continual thorn in the Governmental flesh. Its shortcomings provide abundant matter for criticism in the Press, and are a frequent subject of acrimonious discussion in Parliament, while the public now and then shows its ill-humour in threatening demonstrations. The Minister of Public Works has pledged his word to put an end to these irregularities, but the public would like to have some idea when this much-desired consummation is likely to be achieved. There is no doubt that the Minister is doing his best to put things in order. He has organised and reorganised and made alterations in the executive staff. Each change seems to be making the situation a little bit worse than it was before. Many industries are being stopped through the extreme difficulty of getting deliveries of raw material, which often remains stranded and forgotten for weeks and even months on railway sidings. A curious commentary on the effect of State working is offered in the story of a great artillery firm at Havre, which secured a contract from the War Department, with the usual stipulation of an indemnity for every day exceeding the date fixed for delivery. The firm sent its patterns by rail to the foundry, but they never arrived, and, after a fruitless search, it was obliged to make others, with the result that two months were lost. The negligence of the State Railway was naturally put before the War Department as a valid reason for not inflicting the fine, but the War Department made known to the firm in question that it must try to recover the amount of the indemnity from the State. Thus, instead of two State administrations settling the difference between themselves, one actually incites a firm to take proceedings against the other, the cost being naturally borne by the ratepayers. The situation has become so intolerable that the mayors from the different suburban towns recently called upon the director of the Ouest-Etat Railway to ask when the proposed electrification would be complete. The director was unable to say, because the scheme has not yet received final sanction. Meanwhile, the Minister of Public Works proposes to build a subterranean station at St. Lazare, to increase its capacity for dealing with local traffic, while the terminus for the main lines will be at the Invalides. This revival of an old scheme is likely still further to delay the execution of the project for making the Ouest-Etat a "model railway."

Protection Works in Paris.

The level of the Seine is already rising, and the weather conditions point to a continuance of this state of things; but, for the moment, there is no reason to forecast a repetition of the disastrous floods of 1910. These followed upon an exceptionally wet summer, when the subterranean water everywhere was at a very high level. The past summer was remarkable for the longest period of drought ever recorded, and it may therefore be supposed that the absorption of rains may prevent the rivers from overflowing their banks. Nevertheless, this does not justify delay in carrying out the protective works in Paris, which were proposed by the Commission, under the presidency of M. Alfred Picard, nearly eighteen months ago. The works entailing comparatively small cost are well advanced. Where the embankments are low, barriers of steel sections have been raised ready to be filled up with concrete or masonry. The openings in the embankments have been provided with doors for closing them hermetically, and pumps are available for keeping down the water in the Quai d'Orsay Station in the event of infiltration. Outside Paris embankments have been constructed between the Orleans Railway and the Seine; and, on the whole, everything seems to have been done with the limited funds available for this purpose. As for the more important works, the various projects are still under consideration, and the Commission appointed by the Municipal Council has just presented a further report in which it is stated that the widening of the arm of the Seine at the Monnaie would reduce the level at the Sully bridge by 43 cm., and the effect would be appreciable as far as Charenton. This would mean the reconstruction of three bridges and the displacement of the Orleans line for a distance of 560 m. at a total cost of 28,346,000f. The proposal to deepen the Seine between Suresnes and Bougival is not approved of by the Commission, which prefers the dredging of the river between Paris and Rouen, whereby the level in Paris would be reduced by 1.60 m. This would, however, cost 150,000,000f. This project is associated with the construction of a port outside Paris. The Commission approves in principle of the construction of the overflow canal from the Marne to the Seine, but refuses to entertain it until the other works have been completed. These would entail a total expenditure of 300,000,000f. The whole question now depends upon how much of this will be contributed by the State. Following upon the loan of 900,000,000f. for the embellishment of the city the raising of further funds is by no means an easy matter.

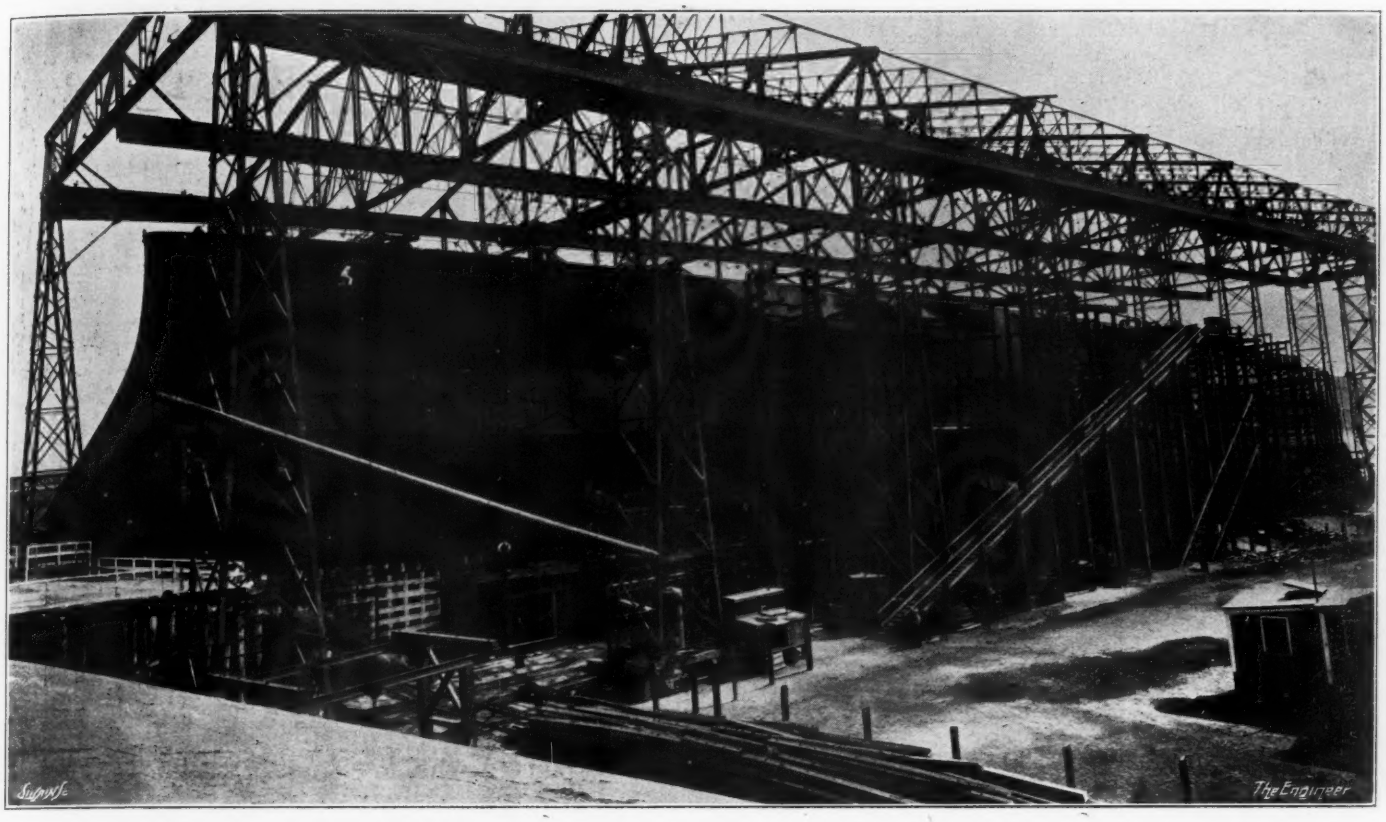
THE MAXIMUM DIMENSIONS OF SHIPS.

In a paper just read before the American Society of Naval Architects in New York on "The Maximum Dimensions of Ships," Sir William White concisely expresses his views on the limitations, and he regards them from the point of view of a naval architect as being more commercial than technical, which are likely to restrict the future dimensions of ships. It is surprising to read his opinion that the upper limit of size for the Transatlantic service has been reached in the Mauretania, because there are at least half-a-dozen larger, if not faster vessels, built and being built for this service, but the reasons he advances are of considerable interest, and we therefore reprint the paper *in extenso* on another page. Sir William prefaces his lecture with three salient questions that have perhaps given to dock boards more food for thought and subject for complaint than to ship owners or to naval architects. Will, he asks, the dimensions of ships continue to grow as fast in the future as in the recent past; will a limit be reached, and, if so, why? If one plots dates as a base, and increments of size or length in successive years, the resultant curve, whether for warships, merchantmen, or submarines, is truly formidable, and indicates further increases in course of time in every direction. As far as the naval architect is concerned, even without any revolutionising novelty in materials of construction or in propelling apparatus, no doubt need be felt as to the technical side of the question, but the commercial aspect is rapidly becoming one in which proportion is giving way to facts of an absolute nature. It is astounding to think that the Germanic was practically only half the length, half the width, and half the depth of the Olympic; she was one-ninth of the gross tonnage and one-tenth of the horse-power. Half way between her and the Olympic, except in point of date, came the Oceanic, which was roughly 50 per cent. bigger in dimensions, only to be similarly superseded last year. With such a record of technical progress it is hard to doubt that the Olympic could be immensely exceeded at the present day, but unfortunately at present neither the Mersey, the Solent nor the Hudson River will accommodate any abnormal increase, especially in draught of water. This is really the principal present technical objection to increase of size. The main reason of increase of size has been the continual desire to obtain on each occasion some further advantage in speed or carrying power, or some other property of equal importance. In some special classes of vessel, more particularly in the Transatlantic trade, this development has been perhaps unduly forced, though recent competition in the size of battleships has been very intense, and it is a curious fact that within a week of Sir William White's expressed conviction that the wiser course in warship building would be found in a return to more moderate dimensions and reduced unit cost, the United States Government should ask for tenders for 30,000-ton battleships—the largest yet proposed, with the exception of the Brazilian ship now being built at Elswick.

Nevertheless, in spite of these special instances, the actual number of vessels of exceptional size for their type is relatively few. The bulk of the maritime business of the world will always be done by ships of relatively moderate dimensions, because instead of being constructed to ply between two or three definite terminal ports of large harbour accommodation and ample depth of water, cargo boats must be made to ply all over the world, if necessary, in order to increase their sphere of utility. To a large extent the same fact applies to warships. It is the volume of the moderate-sized cargo vessels that contributes the largest share of port dues—not the specially constructed racing liner of immense size, for whose benefit the largest dry docks and basins are required. These harbour works are amazingly costly, and, viewed as a commercial investment, cannot pay on the dues from a very few special vessels. Already this pinch of profit-earning necessity has caused no little friction between Harbour Boards and large companies. Where, of course, these works are national this limitation does not intervene, but it must be remembered that in addition to the actual docking facilities the cost of dredging channels may amount to a tremendous sum. Only too often is it found impossible to load existing vessels to the full draughts to which they might be safely laden on account of lack of deep water at harbour mouths. To obviate the necessity of additional draught, and yet to attain the required displacement, builders are being driven more and more to increase the beam, not only of large merchant ships, but also of warships. We drew attention to the effect of this on the dry dock accommodation of the country some time ago, when we showed that there was a lamentable dearth of dock accommodation capable of taking a 90ft. ship. Ample clearance each side must be allowed for docking such vessels, so that the margins that are now available, while perilously small in some cases, may be entirely absorbed at no distant date. While the increase in draught of water during recent years has only gone up about 10 per cent. it is in many cases already excessive, but breadths have increased by about 40 per cent. The Kiel Canal now in course of reconstruction, is being fitted with locks 1080ft. long and 147ft. wide. This, however, is frankly a military venture compared to such an international waterway as the Panama Canal, where the lock width is only 110ft. It will be interesting to see whether the hoped-for stimulus to trade that this monument to American energy is expected to provide will result in having ships of the Adriatic type passing through to Western America.

Sir William remarks that the size of the largest ocean waves remains practically constant, and draws attention to the impossibility of forcing even the largest vessels against a heavy sea. The maintenance of speed in rough weather of course depends, to a large extent, on the relative dimensions of ships and waves, and it is difficult to believe that larger vessels than the Mauretania, which he regards as the upper limit of size, will not suffer less in extreme conditions of weather. This vessel, in

THE ARGENTINE BATTLESHIP RIVADAVIA ON THE STOCKS



spite of her size, has had her bridge fittings severely disarranged on at least one occasion. The figures in the paper dealing with the extraordinary regularity of performance accomplished by this vessel in two years will be read with interest.

In directing attention to the purely commercial side of shipowning, the author gets closer to the real determination of the size of ships. It is in the ability of the owners to make the vessels pay that fixes the proportions. In some ways it is surprising that we have not seen more really large vessels on the Cape Service; any great increase in trade development in South America would certainly result in large vessels being placed on that service until the draught of water for vessels leaving the Plate River becomes such that the local authorities do no not care to dredge further on account of the disproportionate cost. With regard to the Atlantic traffic, very special conditions determine the type of ship. In the first place, the vessels virtually carry cargo only on the eastward run, for there is relatively little import into the States in face of the high tariff. For an "intermediate" type vessel carrying both cargo and passengers, it is highly desirable that the earning capacity from the passenger end shall not be interfered with by undue length of time being taken to discharge and refill with cargo, or, in the case of fast ships, by coaling. If the vessels be of exceptionally large size there is often considerable difficulty in getting the cargo to fill them; this, perhaps, is much more general than is usually supposed; but it is a no less cogent limitation to the size of ships, because unless cargo can be carried sufficiently often and in such quantities as to earn a dividend, the vessels will not be built of a size involving undue capital expenditure.

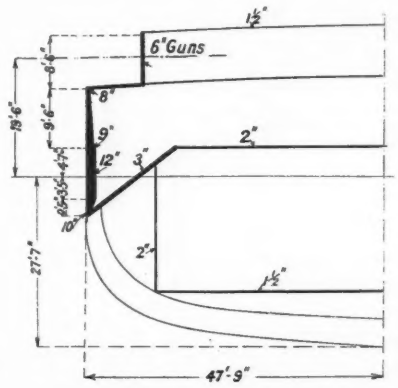
In his final section, Sir William White devotes considerable space to the limitations affecting warship design. Under his control, as Director of Naval Construction, the capital ship in the British Navy departed but little from a displacement of about 15,000 tons, a speed of 18½ knots, and a main armament of four 12in. guns, for a period between the Royal Sovereign class of 1891 and the King Edwards of 1903. A big increase in size, due to the different ideas that were fomented by the Russo-Japanese war, was inevitable when the demand came for an all-big-gun battleship. With two knots increase in speed, a greater radius of action, and three more twin 12in. turrets, a large increase of displacement was inevitable. This, and the speed, involved greater length which was again extended when the system of centre line mounting was introduced in combination with an even heavier primary weapon. There is no sign of this increase in capital ships even waning; bigger guns still are under discussion. As in large merchant vessels, the beam has been greatly increased in relation to the draught, which, however, has remained fairly constant. One reason, at least, for this increase is the fact that it was necessary in the interests of stability in view of the high position of the heavy armament weights. It is certainly surprising to learn from this paper that modern warships are not as steady gun platforms as their predecessors, owing to their initial stability causing them to have relatively short periods of oscillation. They gain, at any rate, the great advantage that they can fight in almost any weather, whereas the older vessels of smaller size were sadly hampered by lack of height of main deck guns above the water. This was a very important reason for increasing the size of ships. We cannot avoid the feeling that Sir William White's preference for the ship of more moderate dimensions has led him to understate the case for the bigger ship. What displacement or length he regards as moderate he does not state, but 75 per cent. of the Lion would still leave us with a bigger ship than the Dreadnought, and it was specially to harass Dreadnoughts that the Lion class was built. That successful under-water attack may put one out of action is very probable, but it will be proportionately more difficult with the larger ship, as obviously a bigger mine or torpedo will be needed, and such could equally be used against and would certainly sink a smaller vessel out of hand. We are inclined to believe that the moderate dimension vessel would stand but little chance with the higher speed torpedo craft now in existence; but, as we said, we are only guessing what moderation means. The Swift, for instance, is a very moderate sized scout, but she is twice as big as any destroyer built. Who is going to set the example of receding from "the extreme dimensions which have recently found favour?" It needs a considerable reduction in size to obtain eight ships for the cost of six larger ones. The question of size of battleships is perhaps rather apart from the title of the paper; but, as far as it is possible to see, there is no chance of any reduction in size, and every appearance points to a considerable increase. Here, however, we are limited by dock accommodation. Even Portsmouth has at present only one dry dock over 90ft. wide, though another is under construction, and a floating dock capable of lifting 85,000 tons and taking a ship of nearly 100ft. should be ready before March. This latter does not sound like moderate dimensions.

If the commercial limitations introduced into the problem by cost of dock accommodation and dredging are analysed, we fancy they will be far less of a hindrance to increase in dimensions than the much more vital question from the shipowner's point of view of getting passengers and cargo to fill them. The history of the Hamburg-American Company and that of the White Star Line is very significant, the latter especially so. By degrees in each succeeding year the latter company steadily increased the size of its ships till the question of available depth of water on leaving New York was the only real bar to further progress. Then the beam was increased without any material change in actual draught, though with an increased permissible immersion which the vessels are unable to use.

It is impossible to imagine any serious slackening off in the trade of the world. The Atlantic trade in passengers especially has increased enormously in late years, and it appears that it must continue to do so. Obviously, with the inevitable increase of trade with Canada, as the population expands, the number of ships required must grow, and it is impossible to doubt that ships will grow correspondingly. Sir William White's able and interesting paper, while it draws attention to the commercial influence of physical limitations at the terminal points and the lack of urgent necessity for increase of size owing to conditions met with at sea, in no way attempts to define—it would be a matter of supreme difficulty to do so—where the line should be drawn in increasing the depth of channels. We hold that this will a be constantly diminishing check on shipping progress. For the price of one ship a great deal of dredging can be done; for the cost of two or three, harbour works, rendering an estuary or bay more or less independent of this continual drain, can be constructed. With an ocean highway like the Atlantic deep and open, it is impossible to believe that Britain, Germany and the United States will remain content with shallow harbours; each nation would spend millions rather than allow interference with her overseas commerce. The question of speed of transit, except in very rough weather, is not alluded to in Sir William's paper, but for all classes of ship there must remain a ratio between this and length of vessel. Is the Mauretania to represent the last word in Transatlantic speed? It would be a bold step to suggest it with the potentialities of improvement in steam motive power available, and if increased speed is looked for the dimensions of ships must rise. One moral that might be drawn from the paper is that a careful analysis of depths of water round the strategic centres of future developments in the world's commerce will amply repay the time spent thereon. But there are few of the more important ship-owning companies that have not this knowledge to hand, and if they require ships of the existing maximum dimensions the building companies are certainly ready to supply them.

THE ARGENTINE BATTLESHIPS MORENO AND RIVADAVIA.

THE arrangement of the two Argentine battleships Moreno and Rivadavia, which are being built at the Fore River Yard, Quincy, in the United States, is shown on



ARRANGEMENT OF ARMOUR AMIDSHIP

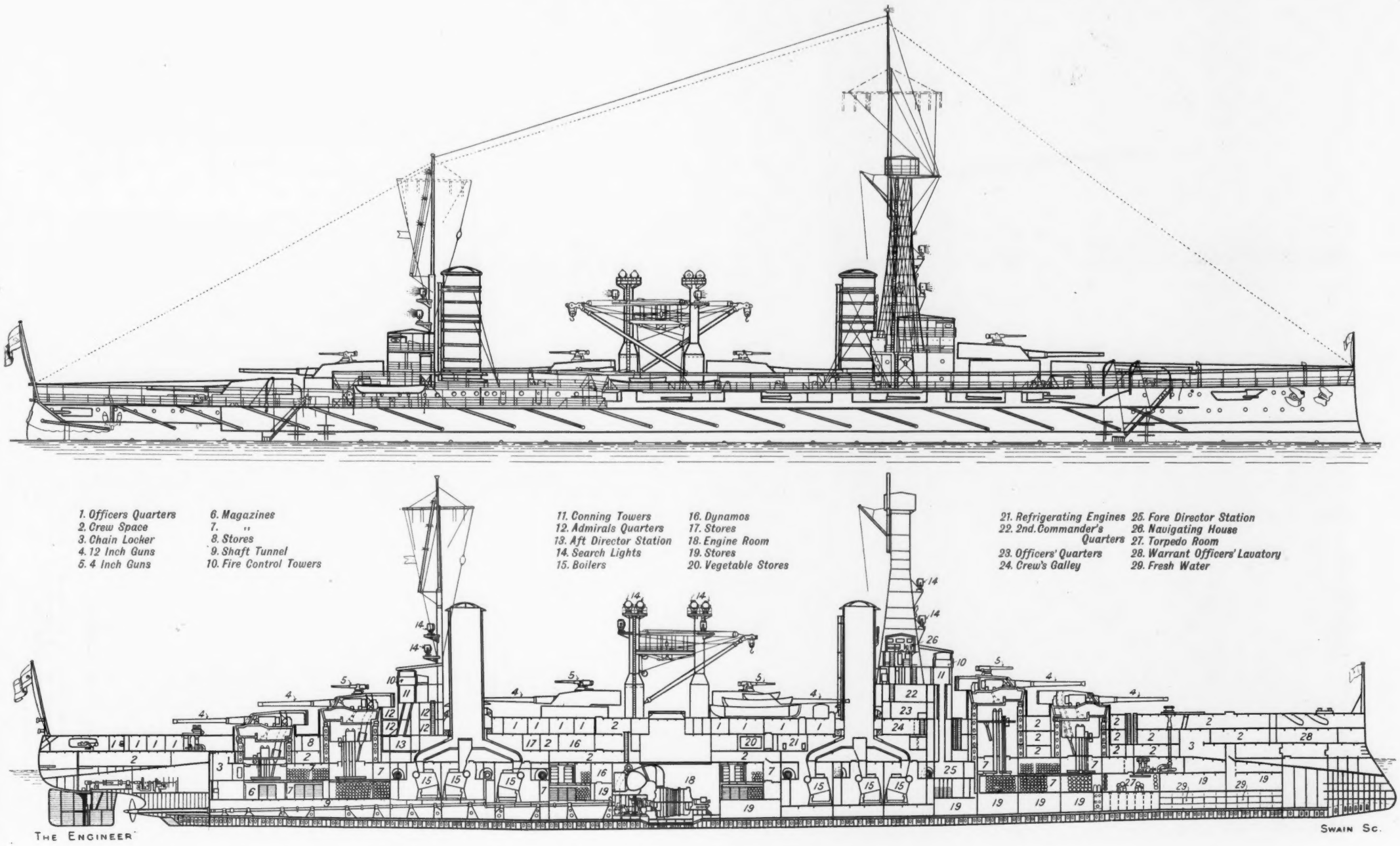
page 556, and various views of the Rivadavia are given above and on page 557.

The Rivadavia was laid down on May 25th, 1910, and was launched on the 26th of August last. The displacement of the vessel is 28,000 tons in speed trial condition, and the corresponding draught is 27.7ft. The other dimensions are: Length, 580ft.; breadth, 95ft. 6in; depth, 49ft. 7in.

The Moreno and Rivadavia are protected by a water-line belt of armour extending from stem to stern, the

THE ARGENTINE BATTLESHIPS RIVADAVIA AND MORENO

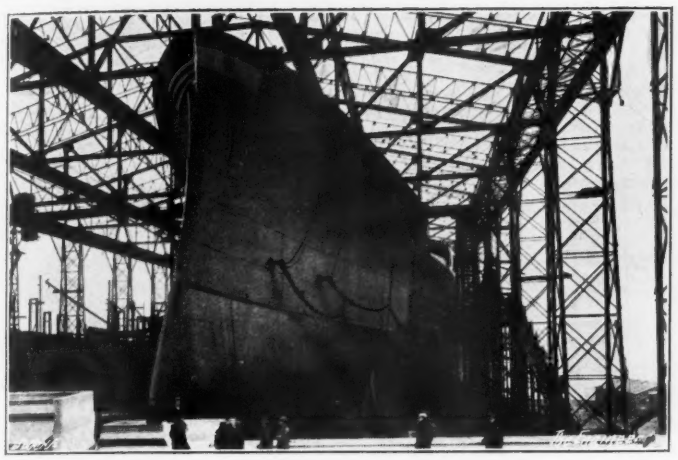
(For description see page 555)



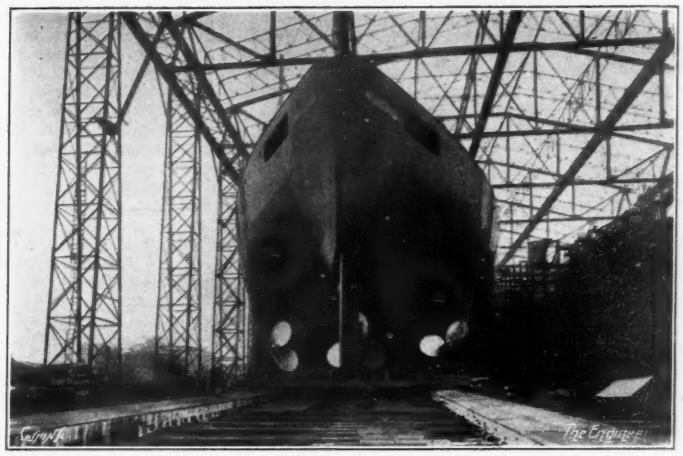
THE ARGENTINE BATTLESHIP RIVADAVIA UNDER CONSTRUCTION

LOOKING FORWARD

LOOKING AFT



BOW VIEW



STERN VIEW

thicknesses of which are: 12in. amidships, for a length of 250ft. and a depth of 4ft. 7in. above and 3ft. 5in. below the water-line, tapered down to 10in. thickness at a depth of 5ft. 10in. below the water-line—see page 555. Fore and aft of the main belt the thickness of the waterline belt is reduced to 10in. as far as the foremost and aftermost 12in. gun mounting, and from these points the thickness is 6in. forward and 4in. aft.

The citadel armour between the armoured deck and the upper deck has a height of 9ft. 6in. and a thickness of 9in. below and 8in. above the upper deck for a length of 400ft. amidships. The thickness of the armour forward and aft of these points is 6in. and 4in. respectively.

The casemate armour extends from the foremost 12in. barbette to the aftermost barbette, and has a height of 8ft. 6in. and a thickness of 6in. The forward conning tower is 12in. thick, the after tower 9in. The thickness of the protected deck is 2in. on the horizontal part and 3in. on slopes.

The armament is to consist of twelve 12in. guns, twelve 6in. guns, and twelve 4in. guns.

The height of the main armament guns above the water line is:—

	ft.	in.
Foremost turret guns	31	8
Superposed turret guns, fore	39	9
Starboard turret guns, fore	31	8
Port turret guns, aft	31	8
Superposed turret guns, aft	31	8
Aftermost turret guns	22	5

The total weight of armour aggregates 7600 tons, 680 tons of which are employed for under-water protection against mines and torpedoes.

The bottom of the magazines are protected by armour and situated at a distance of 13ft. to 14ft. from the outside plating.

The battleships will be driven by three sets of Curtis turbines working on three propellers, and aggregating 40,000 horse-power, the corresponding speed being estimated at 22.5 knots. The fuel-carrying capacity is 4000 tons of coals and 660 tons of oil, the radius of action being 10,500 miles at a speed of 11 knots, 7200 miles at a speed of 15 knots, 3600 miles at a speed of 22.5 knots. The boiler plant is composed of 18 Babcock and Wilcox boilers in six water-tight compartments.

BRIDGE BUILDING IN ALASKA.

No. I.

THE extension of the Copper River and North-Western Railway to Cordova, the seaport on the Pacific coast in Alaska, represents an engineering undertaking of the first magnitude, comprising, as it does, the construction of two notable bridges, one over the Copper River between Miles and Childs Glaciers, in Alaska, and the other over the Kuskulana River.

From the Copper River delta the Copper River and North-Western Railway follows up the left bank of the Copper River to a point ¼ mile above Childs Glacier on the right bank, and about 3 miles below Miles Glacier on the left bank, where the Copper River is crossed a second time, this crossing being necessary to avoid Miles Glacier. The flow of icebergs from Miles Glacier made any construction in the main channels of the river an impossibility during the season of glacial activity, *i.e.*, from June 1st to November 1st, and inadvisable at any time. In 1907 icebergs were observed passing the bridge site that were 20ft. out of the water, and in 1908 they were observed in the channel at the proposed position of the 450ft. span, 50ft. by 100ft., 8ft. out of the water, and moving at the rate of 7.2 miles per hour, notwithstanding the fact that they were dragging on the bottom. From observations the range from low to high water was found to be 24ft., and it was not possible to find any drift to show that the water had ever been higher. In 1908 the break up of the ice in the river took place on June 7th. On February 10th, 1909, some unknown disturbance took place in Miles Glacier, and although the weather was cold the river rose 20ft., taking the ice out completely, and doing some damage to the temporary track across the delta below. The ice that froze up after this flood was not as thick as it had been before, and the river was open on May 9th.

After observing the ice flow for the entire summer of 1908, the following span lengths, numbered from the south side of the river, were decided upon. Span No. 1, 400ft.; span No 2, 300ft.; span No. 3, 450ft.; and span No. 4, 400ft. This arrangement placed each of the piers on a bar, and out of the path of the heaviest flow of ice; in fact, during 1908 no icebergs crossed the site of either of the piers during daylight. It was estimated that spans Nos. 1 and 2 could be safely erected between April 1st, when the wind and general weather conditions would not be very severe, and the breaking up of the river, and whilst span No. 3 could probably be erected in the same way, span No. 4 could be erected on falsework at any time, except during high water. As it was highly important that the bridge should be completed during 1910, span No. 3 was designed to be erected as a cantilever using spans Nos. 2 and 4 as anchor arms. These two last spans were to be connected by temporary members from the top end post pins to the same pins in the 450ft. span with adjusting wedges, in connection with wedges between the end shoes at the expansion end, and cast iron blocks at the fixed end of the 450ft. span to hold the outer end of each half of span No. 3 sufficiently high to be able to make the connection at the centre of the span. The fixed ends of spans Nos. 2 and 4 are next to span No. 3. It was necessary for spans Nos. 2 and 4 to have rigid lower chords, if they were to be used as anchor spans, and span No. 3, so as to be erected as a cantilever, would require a rigid lower chord except the middle panel. Span No. 1 was accordingly designed the same way as spans Nos. 2 and 4 for the sake of uniformity, and on account of the extremely high winds from September to April, these spans were calculated for a wind pressure of 40 lb. per square foot on the loaded structure, and for 60 lb. per square foot on the unloaded structure.

The piers were designed with the top at elevation 168.02, which would place the bottom of the lower chords practically 30ft. above extreme high water, which it was considered would be ample to clear all icebergs passing under the bridge. The great flow of icebergs made detached ice-breakers necessary at piers Nos. 1 and 2, pier No. 3 being situated out of the heavy ice flow at any stage of the river. The ice-breakers and all of the piers are armoured with 56 lb. rails, placed with the ball outwards and flush with the outside of the concrete, the rails being anchored in the concrete with Johnson corrugated bars 4ft. long, passed through holes in the web of the rail at intervals of 24in. and bent inward to the flange. By designing the caissons large enough to allow ample room for the base of the piers there was secured a total load on the foundation of pier No. 3 of 4.08 tons per square foot, by assuming the almost impossible conditions of two maximum loaded trains meeting on the pier, and this without taking into consideration the skin friction, or buoyancy, of the portion below water. As pier No. 3 would have to sustain the greatest load, the matter of sustaining power of the foundation was not further considered. The track reached this bridge site in October, 1908, but for a distance of approximately four miles it was laid temporarily on the surface of the ground, and the severe weather conditions prevented the proper construction of the permanent way that season.

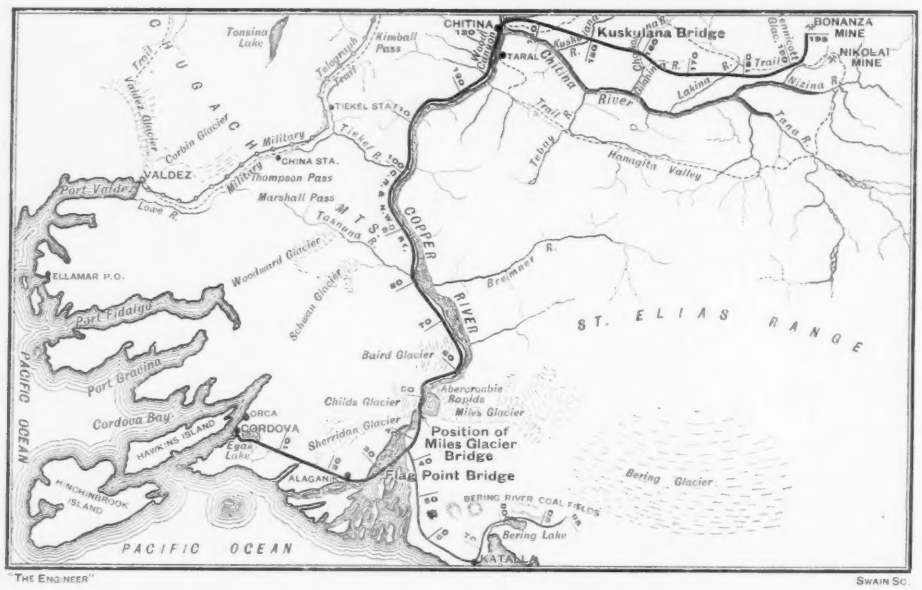
The power-house equipment consisted of six 150 horse-power Erie City, class B, horizontal boilers; four 14in. by 16in. by 18in. duplex air compressors, manufactured by the Chicago Pneumatic Tool Company, each capable of furnishing 1500 cubic feet of free air per minute and compressing to 50 lb.; one Chicago Pneumatic Tool Company's 10in. by 12in. by 10in. compressor capable of compressing to 125 lb.; one Cochrane feed-water heater and one Scaife filter, each capable of supplying boilers aggregating 1000 horse-power; and one 30-kilowatt Ridgeway dynamo with direct-connected 50 horse-power McEwen engine; the filter for the power-house was necessary by the reason of having to obtain the water supply from the Copper River, which carries great quantities of fine silt in suspension. All the equipment was purchased self-contained, in so far as possible, so as to avoid the delay necessary to build substantial foundations for the machines, which were, as a matter of fact, laid on a foundation consisting of 12in. by 12in. timbers, bolted together and resting on the surface of the ground, which consists of gravel and boulders. The only precaution taken was that the timbers were not allowed to rest on filled ground, or, in other words, the ground was excavated

level. The compressors were operated almost continuously from May 4th, 1909, to February 14th, 1910, and the vibration was, we understand, not worth considering.

It was thought that the bridge site would be reached on March 1st, 1909, in time to erect caissons Nos. 1 and 2 on the ice, and sink them simultaneously, and, had this anticipation been realised, the disagreeable and expensive winter work of 1909 and 1910 would have been avoided. Owing, however, to damage to the temporary track in the delta, by a flood in February, 1909, the bridge site was not reached until April 1st, and the last of the material for one caisson was received on the ground on April 24th, 1909. The river at this time showed signs of beginning to break up, and it was deemed unwise to attempt to erect more than one caisson on the ice, it being impossible to hold a caisson in the river after the glacial ice had begun to move, unless it was several feet in the ground. On May 4th caisson No. 1 was completely erected, and although the working chamber was not entirely caulked the caisson was lowered to the bottom of the river and began sinking. At first it was necessary to run three of the compressors to lower the water in the working chamber to within 1ft. of the cutting edge. Caulking was continued while the caisson was being sunk, and in about two weeks the working chamber was so tight that one compressor supplied all the air required. The river began breaking up on May 7th, and on May 9th was entirely free of ice, but there was no flow of glacial ice until June 16th, when the cutting edge was 10ft. below the bed of the river, and the ice did no damage of any consequence.

Previous to the breaking up of the ice there had been put across the river a 1¼in. steel wire cable supported by towers 100ft. high on each bank. This cable was used to deliver concrete and other supplies to the pier and across the river by trolley. The carrier, which was designed and made on the works, had a span of 1800ft., and the heaviest load carried on the cableway was the man lock, weighing 5000 lb. There were also put across the river two 1in. steel cables resting on 60ft. towers on each bank, and on pier No. 3 was made on July 29th, and on August 24th it was founded with the cutting edge 50ft. below the surface of the bar and on boulders and gravel. At the time the caisson was landed the cutting edge was 62ft. below the water surface, and the air pressure required was 26.5 lb. per square inch, or practically the hydrostatic head. This pier was completed on September 15th. At the site of pier No. 2 an artificial island was built in 14ft. of water, by taking out over the cableway shiploads of gravel in coal sacks and dumping them at the proper place. This was begun on September 1st, and, fortunately, the water in the river had fallen so that the velocity of the current in the channel had decreased from 9.5 miles per hour to nearly 7 miles per hour, and 5 miles per hour over the pier site, or this method would have been impossible. The falling of the river had also made it impossible for icebergs of any size to come down; in fact, only two or three small bergs struck the island during its construction, and the amount of damage done was small. The island was completed September 12th. Caisson No. 2 was erected, and sinking begun on September 27th, and on November 2nd it was founded with the cutting edge at practically the same elevation as that of caisson No. 1, or elevation of 81.95. The material traversed after the first 10ft. of boulders and loose gravel—in the river bed proper, not the island—was cemented sand, gravel, and boulders.

As freezing weather had begun by the time the concreting in the pier proper was ready, a house was built entirely enclosing the pier, and leaving a 6ft. space outside of the concrete forms and over the top of the pier. A 2in. pipe was laid spirally around the pier, approximately 6ft. vertically between the coils, and two 20 horse-power boilers were used to supply steam in order to prevent the concrete from freezing. The water for mixing concrete was heated to 100 deg. Fah., and the sand and rock to about 100 deg. Fah. In this way, as the concrete was taken out over the cableway in buckets holding three-quarters of a cubic yard, it was put into the pier at a temperature of about 70 deg. Fah.



"THE ENGINEER" SWAIN SC.

SITE OF THE MILES GLACIER BRIDGE

a 60ft. double tower on the edges of the crib above caisson No. 1. Suspended from these latter cables were carried an 8in. double-riveted, flanged steel pipe, tested for 125 lb. pressure for supplying compressed air to the caissons, and a foot-bridge of 1in. by 12in. planking. Air was supplied through the 8in. pipe to pier No. 3, a distance of 1300ft. from the power-house on the south bank of the river, with a loss of only 1 lb. from the indicated pressure at the power-house.

Caisson No. 1 was landed on July 14th, on boulders and gravel, with the cutting edge 36ft. below the bed of the river. Pier No. 1 was completed on August 24th, without any serious accidents from the ice, although the latter at one time broke part of the forms out, and at another time took out the tower on the crib, which had been supporting the cables for carrying the air supply pipe, just a few minutes after the cables had been transferred to a new tower on 12in. by 12in. timbers, supported by cables slung over the unfinished pier. Caisson No. 3 was erected in June, on the pier site, on a bar, before the river rose. Before the working chamber was completely caulked the water in the river began to rise and the glaciers became active. The caisson was anchored to the shore by long cables, reaching as far up stream as possible, and in a couple of days the caulking was completed. The air was turned on and lowering commenced, but almost immediately afterwards an iceberg broke from Miles Glacier, three miles away, and so large a wave came down the river that the caisson was washed off the cribs and carried 18ft. inshore and 6ft. down stream. The cables by which it was anchored prevented it from going further down stream, and a derrick which it wrecked prevented it from going further inshore. After this it was jacked into position and sunk without special incident or difficulty.

A second rock crusher and concrete mixing plant were set up on the north bank of the river, to supply material for pier No. 3 and for abutment No. 2. A trestle was built from the north shore to the pier, and the necessary material handled over that. A start with the sinking for

The material was taken out for the abutment foundations by open excavation. There were so many boulders in the ground that to drive a cofferdam first and excavate inside of it was impossible; therefore, the excavating was started, and a cofferdam of 4in. by 10in. fir plank was driven as the excavation was carried down, but at no time was the bottom of the cofferdam below the excavation. The only objection to this plan was that it necessitated quite a large pumping plant. To keep the water out of these excavations there were employed two 8in., two 6in., and one 5in. centrifugal pumps, besides two 5in. boiler feed pumps. If the material had not been very compact, this method would have been impossible on account of the size of the excavation, and the fact that it was carried down 16ft. below the elevation of the water in the river at the time the excavation was completed. The boulders taken from the abutment excavations on each side of the river were crushed for use in the concrete by a Gates gyratory crusher set up near each excavation. Sand for the concrete was obtained from three different pits within a radius of half a mile of the work. Tracks were built in the pits and the sand was hauled to the bridge site on cars. Before the ground froze, and the deep snows came in the autumn of 1909, a house was built and sufficient sand and crushed rock stored to complete the masonry. The foundation for all the piers and abutments, except pier No. 3, are cemented sand and gravel, and boulders from 1 cubic foot to 10 cubic yards in volume. Under pier No. 3 the boulders are much smaller, and the sand and gravel, while not cemented, are firm.

AN apparatus has been designed in Switzerland to record telephone messages automatically in the absence of any attendant. The call from the station actuates an electro-magnet which allows the recording cylinder of a phonograph to be put in motion and to receive the message. When the telephone connection is broken a pawl falls into a ratchet wheel and the rotation of the phonograph cylinder is arrested.

NEW MECHANICAL ENGINEERING LABORATORY AT BELFAST.

A NEW mechanical engineering laboratory, which has just been built in connection with the Municipal Technical Institute of Belfast, was formally opened on the 24th November.

The laboratory, which is 114ft. long by 42ft. wide, is situated on the ground floor of the Institute. It is divided into two long bays, and is covered with a glass roof. Two hand travelling cranes, placed at such a height as comfortably to clear all pipes and pieces of machinery, run its whole length. The floor is double, there being a clear space of 3ft. between the levels. This arrangement is very convenient, because it permits the placing of all apparatus not directly needed for experimental purposes out of sight. Furthermore, it permits all shafting to be placed below ground. Access is given to the space between the floors by numerous trap-doors. The laboratory is lighted by sixteen 200 candle-power drawn tungsten lamps with holophane shades, and small electric hand lamps are also provided which can be moved to any machine at will. The underfloor also is illuminated by incandescent lamps. The laboratory is heated in winter by a system of pipes conveying hot water, and is ventilated as part of the general scheme on the Plenum system.

The boiler-house contains a Lancashire boiler, a marine boiler, pumps, water meter, economiser, internal feed-water heater, and induced draught fan with variable speed motor. The feed-water can be heated separately or put through the economiser and the internal feed-heater. Saturated or superheated steam may be drawn off.

The Lancashire boiler, which is 28ft. by 8ft., was manufactured by Joseph Adamson and Co., Manchester. In connection with it a Sugden superheater is installed, and steam temperatures are taken at the inlet and the outlet. The marine boiler, which is 11ft. by 11ft., is by Workman and Clark, Limited, Belfast. Inside the steam space there is a feed-water heater by Hamilton and MacMaster, Belfast. A recording pressure gauge, connected to both boilers, records on a revolving card the variation of steam pressure during twenty-four hours. An economiser by Green and Son, Limited, Wakefield, is employed, and the inlet and outlet temperatures of gases and water are taken by thermometers. The variable speed motor-driven fan is by Musgrave and Co., Limited, Belfast. There are two feed pumps. One is by G. and J. Weir, Limited, Glasgow, and is fitted with indicator cocks for both water and steam; the other is by Frank Pearn and Co., Limited, Manchester, and is similarly equipped. A Kennedy feed-water meter is installed. Space is left in the boiler-house for a tubular boiler. A complete set of feed-tanks is provided under the laboratory floor, from which the volume of feed-water can be measured. Arrangements are made by which platinum thermometers may be inserted in the furnaces, tubes, combustion chambers, flues, and chimney, the temperature record being taken by a Callendar recorder fixed in the main laboratory.

The main steam engine is of the horizontal cross-compound type, and is by Combe, Barbour and Combe, Limited, Belfast. It is of 60 indicated horse-power, at a steam pressure of 120 lb. per square inch, 150 deg. F. superheat, and 100 revolutions per minute. This engine was specially designed for experimental purposes. It is used sometimes as a single-cylinder engine, either condensing or non-condensing, and the piston, piston-rods, &c., are designed for full boiler pressure on the low-pressure cylinder. The high-pressure rods are made the same size as the low-pressure rods for the sake of symmetry. The engine can be used under any of the following conditions, viz.:—(1) Compound condensing; (2) compound non-condensing; (3) single-cylinder condensing (using low-pressure cylinder); and (4) single-cylinder non-condensing (using low-pressure cylinder). A branch is placed on the pipe between the cylinders to which vessels of various size can be attached for experiments demonstrating the effects of different receiver volumes. The fly-wheel is designed for a Prony brake, and has a hollow water cooled rim. In addition to brake tests by weights, the power can be ascertained at a glance by means of a new torsion meter designed by Professor Smith.

The valves are all of the drop piston type, the admission valves being operated by a new form of trip gear designed by Mr. Crawford, of Combe, Barbour and Combe, Limited.

A high-speed engine of 25 brake horse-power at 750 revolutions per minute, by W. H. Allen, Son and Co., Limited, Bedford, is installed. It is coupled to a direct-current generator of 15 kilowatts capacity at 220 volts. It is of the enclosed type, having forced lubrication. The governor is furnished with a hand regulating gear to permit of the speed being adjusted whilst the engine is running. The generator is of the compound type, and the electric load consists of similar unit resistance coils mounted on a framework erected behind the main switch board, the units being thus easily inspected at any time. A 16-kilowatt Parsons turbo-alternator and exciter is also installed. The alternator delivers three-phase current, which is taken to the main switchboard. It is intended to experiment later with this current on some of the machines in the textile laboratory. The equipment also includes a De Laval steam turbine by Greenwood and Batley, Limited, Leeds, of 15 horse-power at 40,000 revolutions per minute, which drives a centrifugal pump through a 10 to 1 gearing. The pump, which lifts 160 gallons of water per minute against a head of 160ft., receives water from the tank under the laboratory upper floor, and delivers it into the large measuring bay. The pump may be disconnected, and in this case a friction brake mounted on the main shaft enables brake horse-power tests to be carried out.

A small Worthington duplex feed pump of the ordinary commercial type draws its water from a small suction tank, and discharges through an air vessel and throttling

valve to an orifice tank. From this the water flows back to the suction tank. A counter records the number of strokes of the pump. An experimental plant for the testing of exhaust and live steam injectors has been erected on the laboratory wall. This also includes a small piece of apparatus for testing the condensation occurring in steam pipes lagged in various ways.

The whole of the condensing plant, which is designed so as to be suitable for dealing with the largest steam unit in the laboratory, is situated in a pit placed centrally with respect to the engines, the pit being enclosed by steel handrails. There are two condensers—(*a*) a surface condenser by Isaac Storey and Sons, Limited, Manchester; and (*b*) an injector condenser by Ledward and Beckett, Limited, London. The former is of the contra-flow type. The condenser is fitted with atmospheric pipe and valve so as to act as an atmospheric condenser when required.

The centrifugal circulating pump of the surface condenser is driven directly by a variable speed Westinghouse direct-current motor operating at 440 volts. The speed can be cut down to one-quarter the maximum in a large number of steps. The pump draws water from one of the large calibrated tanks below the lower floor of the laboratory, each of which is of 5000 gallons capacity, and discharges into a cast iron weir tank, fitted with baffle plates and a rectangular brass weir plate, by means of which the quantity of water is calculated. After passing the weir the water travels back through a specially designed channel to one of the tanks under the lower floor. Arrangements have also been made to employ circulating water from the city water main. The motor above referred to drives also by means of a belt a single-acting Edwards vertical air pump fixed to the side of the condenser. The hot-well discharge passes by a pipe to a measuring tank, consisting of two vessels one above the other, each capable of holding about 100lb. of water, and having brass cocks, gauge glass, and a measuring device. From the measuring tank the condensed steam runs to the laboratory drain. The ejector condenser can also be connected to any of the steam units.

Situated within 6ft. of the high-speed engine and turbo sets is a Westinghouse double-panel marble switchboard. This controls the current from the two dynamos which form the loads for the high-speed engine and turbine. For any power above 10 horse-power loading by means of a brake requires cooling devices, and, moreover, the readings are somewhat unsteady. The electrical method allows the load to be put on in gradual steps, and the readings to be easily taken. In this case it was important that the students should learn various methods of testing and become familiar with electrical instruments. In consequence an Allen direct-current generator, running at 750 revolutions per minute, was attached to the high-speed engine, and a Parsons alternator to the turbine. The direct-current generator is capable of a continuous output of 15 kilowatts at 220 volts. The load is thrown on in steps of 10 ampères.

As water resistances for aborbing the power are inconvenient in many ways, metal resistances of the Westinghouse standard pattern were adopted. A double pole switch, field break switch, field regulating resistance, voltmeter, and ammeter complete the panel. The right-hand panel contains the gear for regulating and controlling the load on the three-phase 16 kilovolt ampères, 200 volt turbo-alternator. The alternator is of the rotating field type. It has two poles and runs at 6000 revolutions per minute. The exciter is fitted with the Parsons compounding device, and, in consequence, at a power factor of unity, the full load may be thrown on with a variation of only 2 per cent. in the voltage. Even if the alternator be accidentally short-circuited, the device prevents the current from reaching a dangerous value. Three separate 25-ampère knife switches with three contacts, one for each phase, control the load. In parallel with these is a rotating switch of the three-phase induction motor starter type. The combination admits of controlling the current in 2-ampère steps from zero to 50 ampères. The instruments on the board consist of a polyphase integrating watt meter—connected through two series transformers) so that the total number of units for the test may be registered, whether the phases are balanced or unbalanced, a watt meter and an ammeter in one of the phases and a volt meter. As in the case of the direct current set, a field regulating resistance for the exciter and a field break switch are also mounted on the panel.

The primary object of an air compression plant, which has also been provided, is to study the efficiency of an ordinary two-stage "Sentinel" air compressor, manufactured by Alley and Maclellan, Limited, Glasgow, and the losses met with. It is belt-driven from shafting below the laboratory floor, this shafting itself being driven by the motor which also drives the centrifugal high-lift pump. Fast and loose pulleys and striking gear are provided. The air pressure generated is from 60 lb. to 80 lb. per square inch.

A small refrigerating plant has been provided. This consists of a refrigerating machine and a liquid air machine. The refrigerating machine is by L. Sterne and Co., Limited, Glasgow, and is employed to produce small quantities of ice and to illustrate the method of cooling by means of a flow of brine. It is installed also with the object of testing the conversion losses in such plants. It is driven from a pulley on the shaft under the upper floor. The liquid air plant is of the type manufactured by the British Oxygen Company. It consists of a Whitehead air compressor, belt-driven from the underground shaft, an air liquefier, and both low and high pressure purifiers. The whole is supplied with fittings necessary to carry out thermodynamical tests. The gas compressor is capable of compressing about 550 cubic feet of gas per hour to a pressure of 150 atmospheres or more when running at 400 revolutions per minute. Under these conditions it requires from 6 to 7 horse-power to drive it, and produces through the liquefier 1½ litres of liquid air per hour.

Various heads of water up to 280ft. are obtained from a motor-driven high-lift turbo-pump, made by Mather and Platt, Limited, Manchester. This pump obtains its supply from either side of the measuring tank sunk in the lower floor. It is used for (*a*) pump testing purposes, and (*b*) supplying pressure water to any one of three experimental turbines. When employed in pump tests it delivers to the cast iron water channel and works against a head produced by throttling a valve. It is of the three-stage type, and is capable of delivering 400 gallons of water per minute at a head of 200ft. The pump is direct driven by a direct-current electric motor of 40 horse-power, 440 volts, and 77 ampères, which is of the inter pole variable speed type, and has a variable resistance of 40 steps corresponding approximately to equal drops of speed. The motor and pump are mounted on one bed-plate and the motor is connected to the pump by a claw clutch. The motor is also used for driving the underground shafting mentioned previously, as used for the compressors, &c. A Venturi tube is used for measuring the quantity of water flowing from the high-lift turbo-pump.

There are three turbines, viz., a Pelton wheel, a Girard, and a Thomson turbine. The Pelton wheel was made by Percy Pitman, London, and develops 5 horse-power with a fall of 75ft. when making 400 revolutions per minute. It has an outer bearing and a brake wheel with hollow rim for water cooling. This machine is fitted with a regulating nozzle and three interchangeable nozzle tips of different diameters mounted on a swivel and having locking arrangements for convenience in changing the nozzles. The inside of the case may be inspected through two openings covered with plate glass, one on each side, while the machine is running. A pressure gauge reading in feet of water is mounted on the wall, and connected to the turbine side of the stop valve, and a counter reading to five figures is suitably mounted and geared to the turbine shaft. The Girard turbine is by Gilbert Gilkes and Co., Limited, Kendal, and has a wheel of about 21in. diameter, and is designed to develop 6 horse-power on a 75ft. head when making 550 revolutions per minute. It has a brake pulley and standard, with water admission pipes and valves, water scoop and drain pipes in connection with the brake. A pressure gauge reading in feet of water is mounted on the laboratory wall near the turbine, and is connected to the turbine side of the stop valve. A counter reading to five figures is geared to the shaft. The Thomson turbine is by Gilbert Gilkes, and gives approximately 4 horse-power with a fall of 75ft. The guides are of brass and have a simple external gear for indicating their position. The turbine is fitted with the necessary brake gear, and, as in the case of the others, a pressure gauge and a counter are supplied.

As apparatus for experiments on pipe friction two ¼in. copper pipes are connected by means of two union joints to points 70ft. apart on a 2in. water main installed below the upper laboratory floor. The other ends of these pipes are brought close together through the upper floor of the laboratory, and are attached to a differential pressure gauge from which the loss of head in feet is obtained. The flow of water is estimated by means of a weighing machine and water tank capable of dealing with 2000 lb. of water. This weighing machine and tank are also employed for calibrating the various measuring tanks. A small electric direct-driven Sirocco fan, a present to the Institute from Messrs. S. Davidson, Belfast, is installed. This apparatus is provided with electrical instruments, air trunk, throttles, sensitive gauges, &c., for the carrying out of complete tests.

The testing of materials is carried out by means of very modern plant. All tension, compression, and cross-breaking testing is carried out on a Riehlé automatic and autographic machine, which is capable of giving a maximum load of 150,000 lb. This machine is of the compound lever type, and it is driven by a Westinghouse direct-current electric motor of 5 horse-power and 440 volts. Eight changes of testing speed are obtained by means of a system of change speed gears and clutches. The lower part of the machine is placed between the two floors, with the consequence that for a 70-ton machine the portion visible is remarkably small. The Riehlé machine is used by students for taking tension tests on all kinds of iron and steel, compression tests on iron, steel, wood, stone, slate, cement, &c., bending tests on iron bars, tests on chains, wire ropes, &c. For experiments on heat treatment of various steels a gas furnace by Mr. S. W. Brayshaw, Manchester, has been provided. This apparatus is heated by a ring of Bunsen burners, and there is provision for forcing the blast if necessary. In connection with this furnace and for boiler experimental purposes a Callander's temperature recorder has been installed.

For the purpose of carrying out tension tests on cement an Adie machine is placed in this section. Students make the cement specimens for themselves from the moulds. The compression tests on cement are usually carried out on 6in. cubes on the Riehlé machine.

Tests on the fatigue of metals are carried out from time to time on a fatigue testing machine, which was specially designed by Professor Smith and constructed by Combe, Barbour and Combe, Limited, Belfast. The machine is driven by a 5 horse-power variable speed Westinghouse motor working at a voltage of 440. Several important researches have already been carried out on this fatigue tester, and others are in progress. A complete electrical equipment for the measurement of heat generated during endurance tests is provided for use with it.

A plant consisting of the necessary grinding and polishing wheels operated by small electric motors is provided for preparing steel specimens for etching previous to microscopical examination. This microscopical examination is made in conjunction with experiments on fatigue of metals and statistical test phenomena, and in connection with this a micro-photographing apparatus is employed. In order to examine the hardness of metals and to compare such results with ordinary tension test results, a Brinell hardness testing machine is placed in the laboratory.

Among the smaller pieces of apparatus are a standard pressure and vacuum gauge tester by Schäffer and Budenberg, Limited, two examples for studying machine balancing problems, and an arrangement by G. Cussons, Manchester, for experimenting on the kinematics of link motions. The laboratory also contains an equipment for testing the elastic strength of flat plates of circular, square, rectangular, and elliptical form.

The plant comprising the internal combustion section includes a gas engine, a suction gas plant, an oil engine, and a petrol engine, calorimeters for determining the calorific value of town's gas, coal, oil, and fuels, and all the necessary indicating and small testing gear. The gas engine is by the National Gas Engine Company, whose usual design has been modified to suit the needs of the laboratory. It is of 20 indicated horse-power when working on ordinary town's gas, and somewhat less when using the suction plant. By a suitable arrangement of valves town or suction gas may be used at will. This engine is chiefly used for indicated and brake horse-power and consumption tests. The fly-wheel, which serves as a brake wheel, has a hollow rim, and a continuous stream of water is kept circulating while the tests are in progress. A brake band with wood sectors and weights are used. Explosion indicators are employed for recording the explosions, but the number of explosions is also registered on a counter. Another counter registers the number of revolutions of the engine. Thermometers placed in cups register the inlet and outlet temperatures of the circulating water, and the quantity of this water is measured by a scale calibrated in pounds per minute. Thermometer cups are provided for the study of cylinder wall temperature, together with an exhaust heat calorimeter of the type devised by Professor Hopkinson. Sampling valves are placed at various points for experiments on gas analysis. The gas consumption is read off on a large 200-light meter placed close to the engine. The calorific value of the gas is determined by a Junker's calorimeter. The most modern planimeters, measuring gauges, and everything for accurate testing are provided. The suction gas plant was made by the National Gas Engine Company.

The oil engine is of the Blackstone well-known make. It is of 12 indicated horse-power, and is so far modified from the commercial type as to permit of indicated and brake horse-power and consumption tests being carried out with the minimum of adjustment, as in the case of the gas engine. The equipment of details is similar in all respects to that of the gas engine. The petrol engine is of about 4 horse-power. A special pulley is mounted on the crank shaft for taking the brake horse-power. The indicated horse-power is taken by means of a beam of acetylene light, and the diagram is reflected on to the glass screen in front of the indicating apparatus. The indicating gear was supplied by Hospitalier-Carpenter Vanraden and Co., Limited, Coventry.

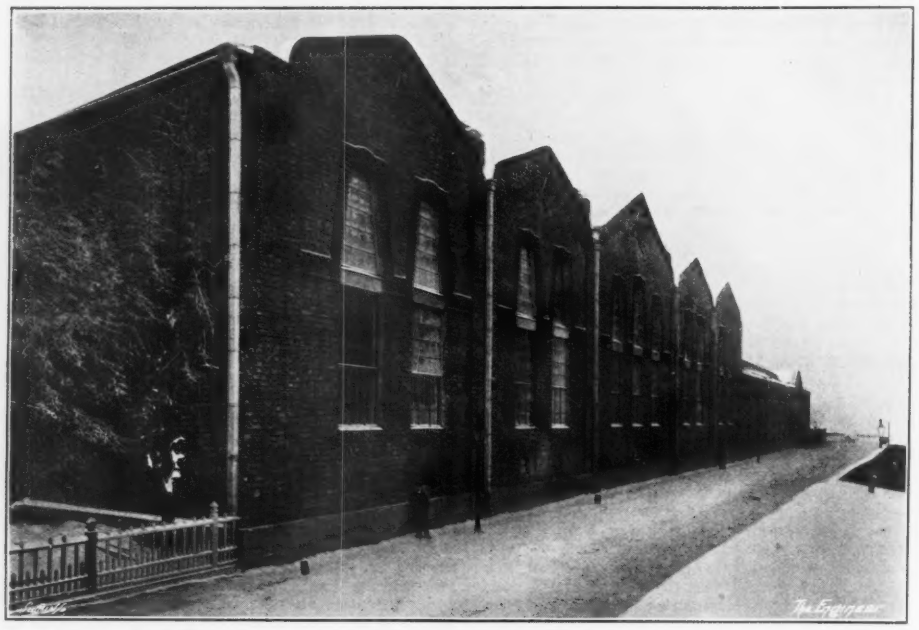
The machine shop, which is equipped with modern high-grade tools and machines, is situated on the ground floor close to the main engineering laboratory. The pattern shop is at the far end of the machine shop, being divided from it by a glass partition, such that the teacher in charge may keep an eye on both departments.

The room is lighted at night by enclosed arc lamps, and in addition portable incandescent lamps are arranged for use on each machine. The machines installed are as follows:—One universal milling machine (for cutting spiral gears, spur and bevel gears, &c.), with universal attachment, by Brown and Sharpe; one Bateman high-speed planer; one high-speed screw-cutting lathe, with special gear head, by Pollock and Macnab; one boring and surfacing lathe, with patent variable speed gear, by John Lang and Sons; six small screw-cutting lathes, by J. Parkinson and Son; one Hendey Norton screw-cutting lathe; one capstan lathe, by Alfred Herbert; one small screw-cutting lathe, by Dempster, Moore and Co.; one vertical automatic drilling machine, by the American Tool Works; one sensitive drilling machine, by Ludw. Loewe and Co.; one shaping machine, with swivel vice attachment, by the Potter and Johnstone Machine Company; one twist drill grinder; one cutter and reamer grinder, by Ludw. Loewe and Co.; one Globe tool grinder, by D. S. Walker and Co.; one Paragon grindstone; two gas forges and anvils; one brazing apparatus; one marking-off table; and sixteen vices, arranged along the working benches. In addition to the foregoing all the necessary smiths' tools and engineers' small tools are supplied. The pattern shop contains the following:—One hand-turning lathe, by Selig, Sonnenthal and Co.; six benches, each fitted with two Emmerts' pattern-makers' vices; one circular saw, by John Elsworth and Sons; one band saw, by S. Sagar and Co.; and one wood trimmer, by the Oliver Machinery Company.

The tool-room is equipped with modern gauges, measuring instruments, twist drills, cutters, reamers, &c., and a complete set of woodworking tools are also supplied. The engineering department also includes three lecture-rooms, three drawing-rooms, one electric photographing room, and a mechanical laboratory. These rooms are fitted up with the diagrams, models, charts, and small apparatus, together with numerous mechanical experimental pieces, lantern slides, &c.

IN his recent financial statement the Minister of Finance of New Zealand announces officially that the Government intends to establish an iron industry in the Dominion. The Government has received an offer to establish works in return for an annual contribution for forty years, but it desires the period to be reduced and provision made for the acquisition of the works by the Government at any time after reasonable notice. If private enterprise is not attracted to the iron industry on these terms, the Government will consider immediately the expediency of developing the iron resources of the Dominion as a State enterprise. State assistance is also to be given to the development of the iron ore and iron sand deposits, on condition that the State shall have the right of acquiring the works and fields.

WATER STERILIZING BUILDING AT ST. PETERSBURG



THE NEW WATER PURIFICATION WORKS AT ST. PETERSBURG.

NEW water purification works have been erected at St. Petersburg which depend upon ozone as the purifying agent, and a district of that city which consumes 50,000 cubic metres—say, 11,000,000 gallons—per day is supplied from these works. Although ozone has been applied to water purification upon a large scale since 1901, the success attained by the early installations was not striking, and it is only during the past two years that a notable advance has been made. Messrs. Siemens and Halske, of Berlin, who have made a special feature of this application of ozone, can, however, now point to twelve installations of this type in various towns and cities of Europe, and to a still larger number of private installations using ozone for sterilising the water supply. Paris, Nice, Florence, and St. Petersburg are the most prominent continental cities that have adopted this method of purification, and plants are already in operation which have a combined capacity of some 26 million gallons of water per day, while the number of public purification works of this character is rapidly increasing. The following details and photographs of the St. Petersburg works should therefore prove of interest to many of our readers.

Fig. 1 is a diagram of the arrangement of the plant in these works, and shows that the water is pumped directly from the river Neva into a settling tank, being dosed in its passage to this tank with a weak solution of aluminium sulphate, which helps to remove certain of the suspended and dissolved impurities. The St. Petersburg plant comprises eight of these settling tanks—see the left-hand top view on page 564—and these are connected directly to the rapid sand filters, thirty-eight in number, shown in the two upper views on page 564. These sand filters are constructed on the Howatson system, and are filled, not with the ordinary filter sand, but with prepared flint, which permits a higher rate of filtration—4.5 m. per square metre of filter surface per hour—to be attained. The filters are cleaned by reversing the water flow through them, and by raking over the surface of the flint filling with mechanical rakes. The chemically treated and filtered water now passes to five sterilisation towers—see the left-hand lower view on page 564—in which it receives the final treatment with ozone, four towers being kept in use and one held in reserve.

The ozonising battery—which is illustrated in the right-hand bottom view on page 564—consists of 128 ozonisers of the Siemens and Halske pattern. In this type of ozoniser the oxygen of the air is converted into ozone by a silent electric discharge, which passes between metal electrodes maintained at a high potential, but separated by glass to prevent sparking. The air, before passing into the ozonisers, is passed through a freezing machine in order to remove the dust and moisture, and a concentration of 2.5 grammes of ozone per cubic metre of air is finally obtained, this being found to be the most suitable concentration for the after treatment of the water. The movement of the air through the ozonisers and its intimate mixture with the water to be purified is effected without the aid of pumps by "emulsifiers" of the Otto type.

These "emulsifiers" are simply water pumps working on the injector principle. Under a water pressure of 4 m. the pumps draw the ozonised air out of the ozonisers, and force it—in intimate mixture with the water—into the sterilisation towers. The absorption of the ozone, and accompanying sterilisation of the water, occurs partly in the pump or "emulsifier" and partly in the towers, as shown in Fig. 1. From these towers the purified water passes away over cascades, which remove the last traces of free gases and ozone, into the storage tanks, from which it is pumped into the city network of supply pipes.

The electric power for running this plant is provided by an independent generating works, comprising boilers, steam engines, and three-phase generators. Fig. 2 shows the engine-room of the installation, with the high-frequency transformers on the left, a current at 7000 volts being required to operate the ozoniser battery. The engine equipment consists of two steam engines, each of 150 horse-power, direct-coupled to two three-phase generators. A third unit is kept as a stand-by, while a 30 per cent. reserve is also kept in all parts of the remaining plant. With regard to the power required, it must be noted that the 300 horse-power suffices not only to work the ozoniser battery, but to operate the numerous motors which are installed in connection with the filtering portion of the plant.

As regards the cost of operating this installation, it is calculated from the results so far obtained that the total cost—inclusive of the preliminary chemical treatment and filtration—is 1.6 to 1.8 pfg. per cubic metre, which represents from 8½d. to 9½d. per 1000 gallons, whereas the cost of the ozone treatment alone is only about one-half this amount. Under German conditions of labour the cost of the ozone treatment works out to 3½d. per 1000 gallons.

As regards the physical and bacteriological results, the expectations of the designers and engineers of the works have, it is stated, been quite fulfilled, the dirty contaminated water of the river Neva being, by this combination of chemical treatment, sand filtration, and ozone treatment, converted into a drinking water which is declared to be perfectly clear and hygienic, and to contain but few bacteria and none of the germs that produce cholera or typhoid fever. The city authorities of St. Petersburg have appointed a commission of experts to control the operation of this new waterworks, and the bacteriological effects of the treatment with ozone are under special observation. So far it is reported that this commission is abundantly satisfied with the results obtained.

The works, an external view of which is shown herewith, have been erected by the Russian branch of the Siemens and Halske firm to the order of the city authorities of St. Petersburg, and for the first year the works are being operated by the technical staff of the German firm. The Compagnie de l'Ozone, which owns the Otto patents for the emulsifiers, and the firm of Felten and Guilleaume also supplied portions of the electrical and other plant.

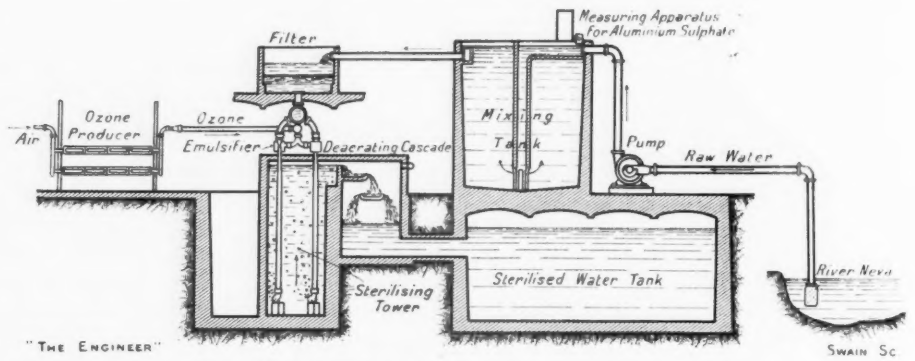


Fig. 1—ARRANGEMENT OF OZONE WATER PURIFYING PLANT

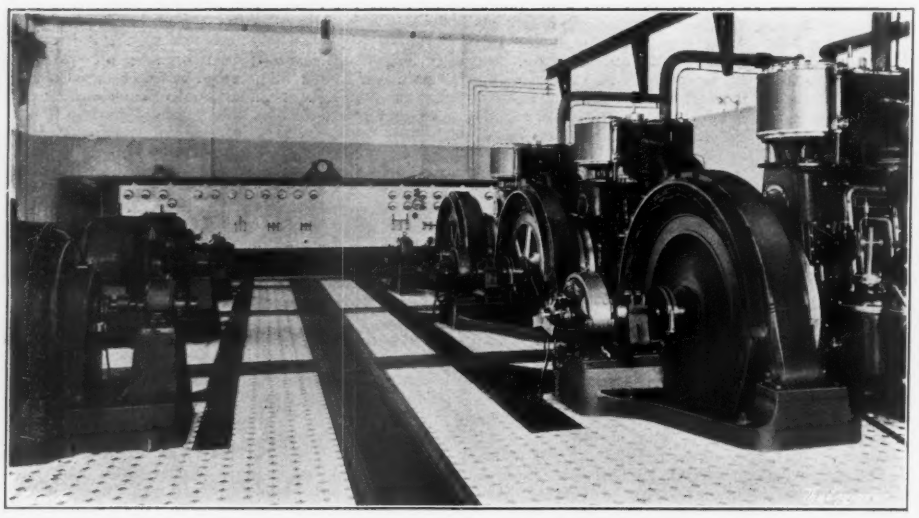


Fig. 2—ENGINE-ROOM OF THE WATER STERILIZING PLANT

AUTOMATIC TELEPHONE EXCHANGES.

IN our last issue we referred to the fact that the British Insulated and Helsby Cable Company is introducing the automatic telephone exchange system into this country, and we endeavoured to give a rough idea of the principle on which the system is worked. It was explained that the instruments are fitted with dial switches, with the aid of which it is possible to get into communication with any subscriber without previous conversation with operators at the exchanges. In the case of a three-wire system, the act of revolving the dial switch intermittently earths one or other of the wires, thus completing a circuit from a central battery, and causes electro-magnetic mechanism to perform certain functions.

In a later system the dial switch intermittently opens the circuit which has been previously completed by lifting the receiver. In the diagram—Fig. 1—the connections are shown for a connector, which is the most important piece of apparatus at the exchange. The teeth by which the central spindle is lifted and turned are clearly shown; likewise the electro-magnets which give rise to the rotary and vertical movements. The magnets which act on the vertical teeth are marked V V, whilst those which act on the teeth which surround the shaft are marked R R. The contact springs or wipers, which wipe over the contacts associated with the lines to be called, are to be seen at the lower part of the diagram. The contacts above these are connected to the test or line engaging circuits which are purely local and correspond to the wires connecting the jack bushes together in a manual exchange. As previously explained, as the shaft rises, owing to the impulses set up by the subscriber's dial switch, the wipers come to rest in line with the contact levels, so that when the shaft is rotated, by another series of impulses, the wipers brush over the contacts in the arc and come to rest on the contacts of the line required. When the receiver is replaced after a conversation, the circuit is opened and the release magnet marked Rel. M operates on the "dogs," which maintained the shaft in the position brought about by the electro-magnets previously referred to. On the shaft being released, it is rotated in the reverse direction by means of the coiled spring shown

in the upper part of the diagram, and at a certain point it is free to fall by gravity to the normal position.

"From the same diagram it will be observed that these magnets are connected in local circuits, which are controlled principally by two relays connected across the line circuit, and through the windings of these two relays the current for the microphone of the calling subscriber is fed. One line relay is known as the vertical relay and the other as the rotary relay. As a matter of fact, the former controls both the vertical and rotary movements, the latter relay being the circuit changing or switching relay. From the diagram it will be noticed that there is a four-lever three-position switch, which

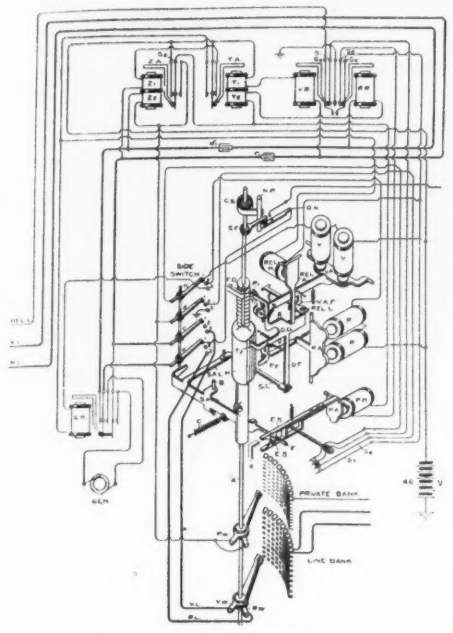


Fig. 1—COMMON BATTERY CONNECTOR

is marked "side switch," and to understand how this is operated it is necessary to return to the dial on the subscribers' instrument. After every series of impulses sent through the vertical relay wire corresponding to a given number on the dial, one impulse is sent over the opposite wire, which actuates the circuit-changing relay which controls the private magnet P M. This extra impulse causes the side switch to step one position after each figure, first to change from the vertical electro-magnet V V to the rotary electro-magnet R R, and secondly to join the lines through. When the two lines are connected the circuit is a clean straight through one.

For an exchange containing from 100 to 1000 lines a selector is fitted, the connections for which are shown in Fig. 2. Its

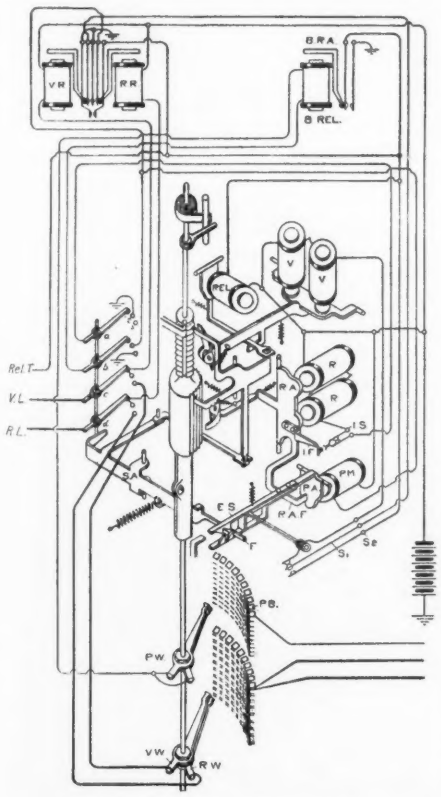


Fig. 2—SELECTOR CONNECTIONS

operation differs from that of the connector in that after the shaft has been raised, owing to impulses set up by a dial switch, it rotates automatically until a junction is found to a disengaged connector. This is brought about in the following manner:—After the impulses from the dial switch have raised the shaft and the earth on the rotary line has actuated the private magnet P M, which moved the side switch to the second position, a local circuit is completed from earth through lever A of the side switch through contacts I S through electro-magnet R to battery and earth. The shaft is rotated one step, and the armature P A is depressed by the extension R A F. If the line to a connector is idle the private magnet P M will move the side switch to the third position when the line is joined through. But should the line be engaged, the armature P A is held down, as a circuit is completed from earth on the private bank through a coil of B relay, side switch lever *b* in the second position, private magnet P M to battery and earth. The electro-magnet R R attracting its armature R A by finger I F opens the circuit at the springs I S, so that the armature is released. The armature is re-attracted and its movement continues rotating the shaft until the wipers engage with the idle line, when the private magnet armature P A is released and moves the side switch to the third position, when the lines are joined through.

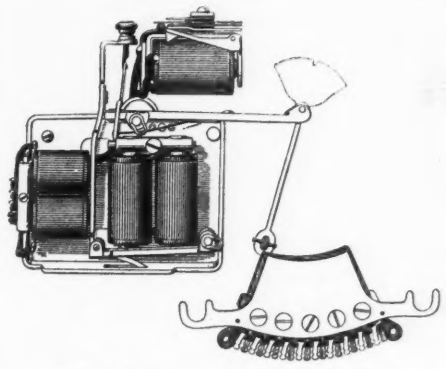


Fig. 3—KEITH THREE-WIRE LINE SWITCH

The selector is then entirely cut off from the lines, these being joined straight through. A Keith line switch, as shown in Fig. 3, is now introduced between the subscriber's line and a selector. This is used in order to obviate the necessity for having a selector for each line. The circuit connections for this switch are shown in Fig. 4. Each circuit has its line and cut-off relay like the manual exchange, and a release relay. These are arranged on each side of a vertical moving shaft in groups of 25 and 12 on one side and 13 on the other. This shaft is pivoted and has a backward and forward movement.

Each relay has a pivoted arm or plunger whose fan-shaped end has a notch which under normal conditions engages with the moving shaft. As the shaft moves it carries the plungers with it and causes them to move on their pivots, so that the point which carries an ebonite roller is moving in front of sets of springs. One bank of 10 groups of springs is in line with each plunger. The corresponding groups of springs in a unit are connected to a selector. This unit is usually made up of four sections of 25, with which 10 selectors are associated, and the shaft is rocked by a master electro-magnet. When the telephone receiver is removed, and before the dial switch is touched, the line switch is automatically operated. The line or tripping relay has disengaged the plunger arm, and a spring drives the plunger into a group of springs and also disengages it from the shaft, so that the subscriber's line has been extended to a selector. At the same time local circuits have been completed through the cut-off relay and the master switch electro-magnet, so that the shaft is moved one step and the remaining 99 line relay plungers are opposite the group of springs belonging to No. 2 selector. The next call will engage No. 2, and the remaining 98 will be carried opposite No. 3, the selector being thus always pre-selected. As the plungers become free, the shaft picks them up on the return journey. In a two-wire system the mechanism is very similar to that of a three-wire system, but the electro-magnets or relays controlling these are different. Advantage is taken of the slow-acting charac-

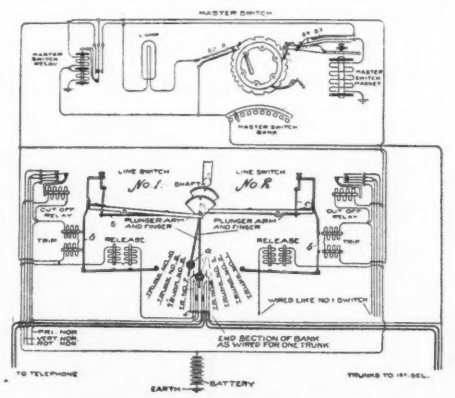


Fig. 4—LINE AND MASTER SWITCHES

teristic of relays having a mass of copper attached, so that the two relays in series are actuated by the first completion of the circuit, but only one responds to the dial impulses. The two-wire circuits of a 1000-line exchange are shown in Figs. 5 to 8.

The master switch is shown controlled by a spring, which is kept wound by a small motor, but the arrangement shown in Fig. 4 is generally adopted. In these circuits the system of registering calls is shown, and this somewhat complicates matters. Referring to Fig. 5, when a receiver is removed to initiate a call, a circuit is completed from earth 1, springs 2 and 3, line 4, receiver R, microphone M, line 5, springs 6 and 7, windings 8, springs 9 and 10 of master and relay switch to battery. The armature 11 is pulled up and completes a circuit from earth 1, springs 2 and 12, through windings 13 and 14 to battery; and armatures 15 and 16 are attracted. Armature 15 causes springs 3 and 6 to break contact from springs 2 and 7 and cuts out the winding 8 from the line. The armature 11, however, is momentarily retained by winding 14 until another circuit is completed, when armature 16 short-circuits winding 14 by contacts 17 and 18. Armature 16 carries the plunger 20, which normally engages with the moving vertical bar. When armature 16 is attracted, therefore, the plunger 20 is forced forward until the insulated disc passing between the springs in the bank causes them to make the contacts show at 21.

Line 4 is then extended by contacts *d* of the bank springs 21 and by contact *a* of side switch 25—Fig. 6—through one winding of selector line relay 26 to earth. Line 5 is extended through meter winding 27—Fig. 5—contact *a* of the bank springs 21, through contact *a* of the side switch 22—Fig. 6—through the other windings of relay 26 to battery, and the line relay is energised. This in turn closes the circuit through the guarding relay 27, which, on being energised, completes a circuit from earth 28, through the upper contact of relay 27, contact *b* of bank springs 21, winding 29 of the line switch magnet to battery, and this circuit maintains the line switch energised after winding 14 has been short-circuited. Relay 27 also completes a circuit by line 28 through contact *b* of the bank springs 21, through meter winding 30, contact 31, spring 17, and contact 18 of the line switch to the battery. As current is then passing through both windings in opposite directions, the meter is not actuated. Relay 27 also puts earth on the wire 28 to the private bank to engage the line. When the plunger 20—Fig. 5—enters the group of springs 21, a circuit is also completed from earth by the contact C, through the master switch bank contacts 32, by bridge 33 to the common connector 34, relay winding 35 to battery. All the line plungers are therefore rotated to the next disengaged contact or junction by the relay 35 attracting its armature and allow-

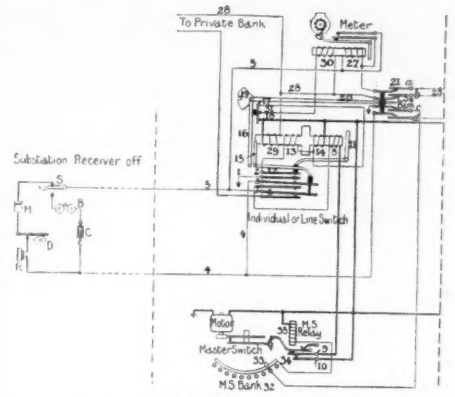


Fig.5—1000-LINE EXCHANGE, PART I.

ing a spring, which is motor controlled, to revolve the shaft. The battery is also cut off all lines at springs 9 and 10, so that no call can be made whilst the shaft is rotating. Therefore by the removal of the receiver a subscriber's line is extended to the first selector by a junction line pre-selected; the line switch is cut off the line circuit, and is retained in a local circuit. One coil of the meter remains in circuit with one wire. The calling line has an engaging current supplied to the private bank; the master switch has carried all the line switches of a group opposite the next junction to the first selector, and the circuit is ready for the impulses which are transmitted from the dial switch.

Suppose the number wanted is 734. With a finger in the hole 7 the subscriber revolves the dial to the stop and the circuit at the instrument is opened seven times. The selector line relay 26 is de-energised seven times. The release relay 27—Fig. 6—is slow in action, and does not de-energise. Relay 26 therefore completes a circuit seven times from earth on the middle spring under contact, through the lower back contact on relay 27, line 37, through the winding of the private magnet relay 37, through the winding of the vertical magnet 38, through the side switch 23 by contact *a* to battery. The vertical shaft therefore lifts the wipers to the seventh bank level.

Private magnet relay 37, when energised, completes a circuit through the private magnet 41. The private magnet relay 37 de-energises after the seventh impulse, and in turn de-energises the private magnet 41, and allows the side switches to pass to the second position, when another circuit is completed from earth 36, contact springs and the winding of the rotary electro-magnet 39, through the winding of the guarding relay 40, through side switch 23, by contact *b* to the battery. The wiper shaft is therefore rotated one step, and the wipers come to rest if that connector line is free. The rotary magnet 39 closes the armature of the private magnet 41, and also opens the circuit as shown at 39 by separating the springs. The armature of 39, therefore, falls back, and the armature of the private magnet 41 also, and allows the side switches to pass to the third position. If, however, the first connector circuit on that level is engaged a circuit will be completed from earth through wiper *b*, line 24, through side switch 24 by contact *b*, through private magnet 41 to battery. The armature of private magnet 41, therefore, remains attracted. The armature of the rotary magnet 39 is re-attracted and continues vibrating, at the same time moving the wiper *b* from contact to contact until a free line is obtained, when the private magnet armature 41 falls back and allows the side switch to pass to the third or *c* position.

The calling subscriber's line—wires 4 and 5—are then connected to the selector wipers *a* and *c*; all selector electro-magnets are cut off the line circuit and the apparatus is maintained in the through position by the wiper *b* completing a circuit from earth through wire 24, side switch 24 by contact *c* under contact of relay 40, line 27, through the winding of the release relay 27 to the battery. When the selector wipers *a* and *c* make contact with the line tabs on the bank, the wires 5 and 4 are connected through the two windings of relay 42—Fig. 7—to the battery and the earth, and this relay is immediately energised as the circuit is completed through the calling instrument. The wire 4 is connected by line switch bank 21, contact *d*, side switch 25 in *c* position, wiper *c*, line 4 and 4A bottom contact of relay 43, lower winding of relay 42 to side switch 47 by contact *a* to earth. The wire 5 is also connected by line switch bank 21, contact *a*, side switch 22 in *c* position to wiper *a*, by the upper under contact of relay 43 to the upper winding of relay 42 to battery. When relay 42 is energised it completes a circuit from earth by the back contact through the winding of the relay 49 to the battery. Relay 49 completes the retaining circuit—relay 27—to earth from wiper *b* of the selector through the

upper back contact of relay 49 to the side switch 45 by contact *a* to earth. Relay 49 is slow acting, and does not de-energise when impulses are sent through relay 42.

As previously stated, number 734 is being called, but, so far, only seven impulses have been sent. The finger is now placed on the figure 3 and the dial revolved. The circuit at the subscriber's instrument is opened three times, and the relay 42—Fig. 7—pulsates three times. A circuit is completed three times from earth by the under contact of relay 42, the back contact of the lower group of springs, relay 49, line 50, through the winding of the private magnet, relay 50, winding of the vertical magnet 51, side switch 44, by contact *a* to the battery. The vertical magnet therefore lifts the shaft with the wipers to the third bank level. At the same time the private magnet relay 50 has been energised and completes a circuit from earth by the back contact of relay 50, through the winding of the private magnet 54 to the battery, and the called at wiper *e* from earth, the switch 46, by contact *c* to wiper *e*, winding 56 of line switch of the called line to battery. The line switch is energised, the armature 57 being attracted and the circuit completed from wiper *d* by line 62 to the telephone and the line switch coils cut off from the line called.

The side switch 44 in the third position completes a circuit from earth through interrupter 58, ringing relay winding 55, line 55, through central under contact of relay 43, through side switch 44 by contact *c* to the battery, and relay 55 is energised. Relay 55 cuts off the calling line and intermittently connects the called line to the ringing generator 59. When the receiver is lifted to answer a call a circuit is completed from earth, through the side switch 46 by contact *c*, lower winding of relay 60, lower under contact of relay 55, side switch 48 by contact *c*, to wiper *f*, line 61—Fig. 8—receiver R^1, and microphone M^1, switch hook upper contact, at contact *c* to wiper *e*, through winding 56 of the individual switch to battery. Another connector wiper now making connection with the same line by a multiple bank contact will complete a circuit from earth by way of switch 46—contact *c*—wiper and bank contact *e* of the engaged line, contact bank and wiper e^1, side switch 46^1 by contact *b* middle under contact, and winding of relay 52^1 under contact of the private magnet relay 50^1, lines 52 and 54, private magnet winding 54^1 to battery, all on the connector of the line attempting to call the circuit already engaged. When the private magnet opens the circuit of the calling line the other wire from wiper *f* is opened at the side switch contact *c*. The energising of relay 52 causes it to close its middle outer contact, so that the circuit of relays 54 and 52 is completed by the upper back contact of relay 49 to the side switch 45 by contact *b* to earth, in order further to safeguard the line attempted to be called.

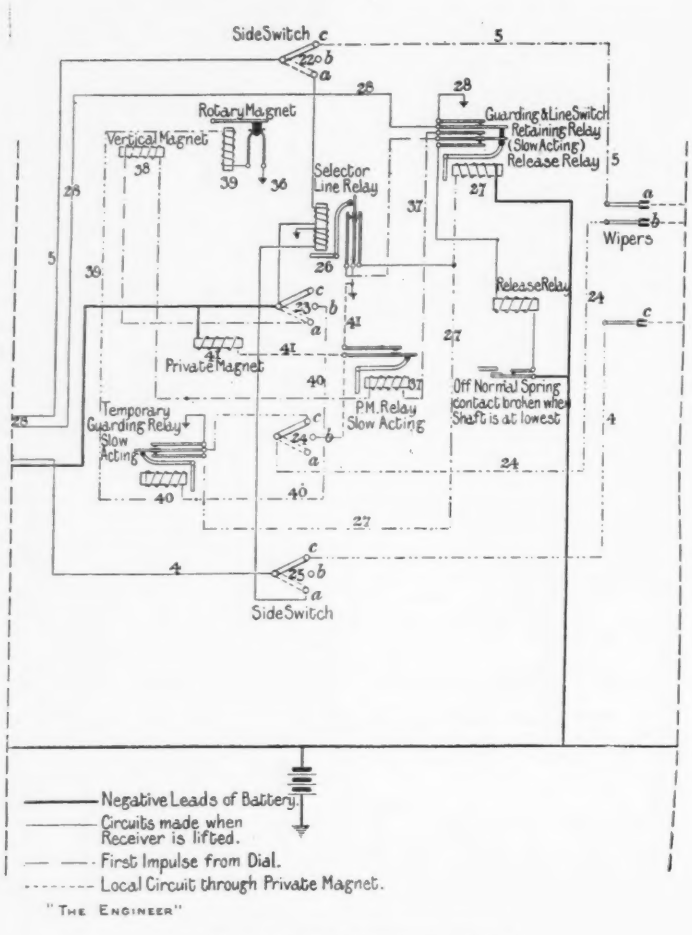


Fig. 6—1000-LINE EXCHANGE, PART II.

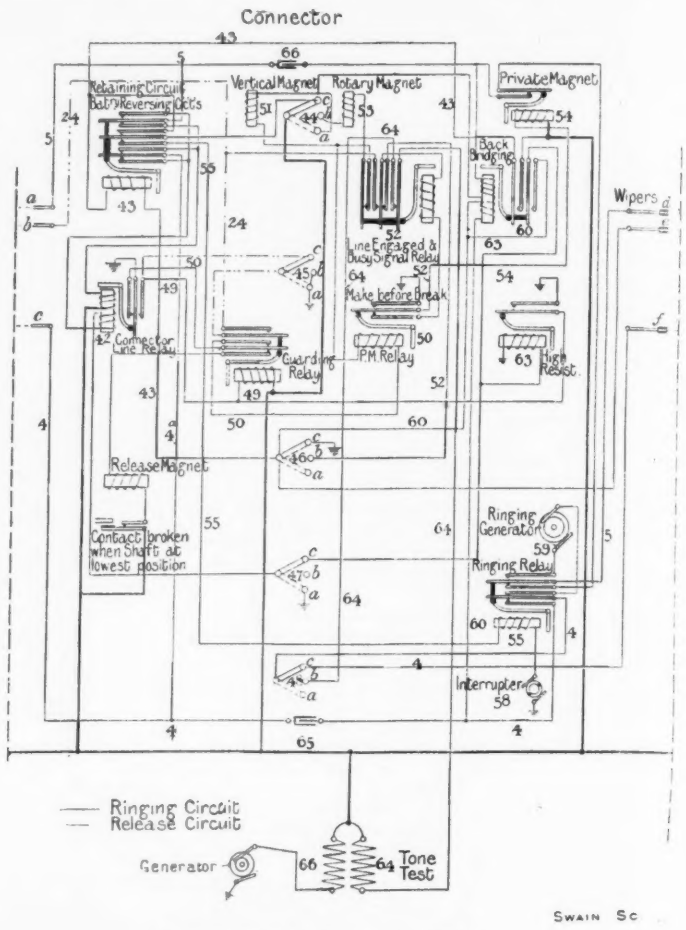


Fig. 7—1000-LINE EXCHANGE, PART III.

private magnet has been actuated and has opened the line circuit. Relay 42 remains energised and the circuit of the private magnet relay 50 is therefore broken; the private magnet circuit 54 is likewise broken, and the side switches are allowed to pass to the second position. The finger is then placed in the hole over the figure 4 and the dial revolved. Relay 42 is again actuated four times, completing a circuit four times from earth by the back contact of relay 42, back contact of the lower group of springs 49, winding 50 of the private magnet outside under contact of relay 52, rotary magnet 53, side switch 44 by contact *b* to battery. The

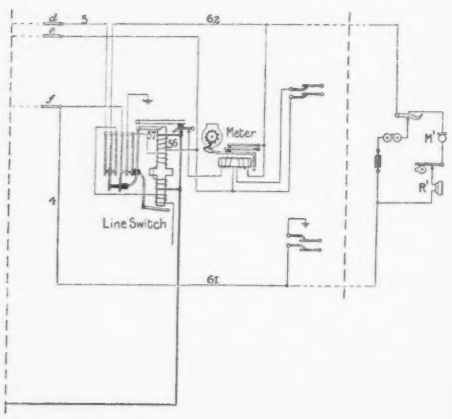


Fig. 8—1000-LINE EXCHANGE, PART IV.

rotary magnet 53 therefore moves the wipers to the fourth group of springs of the connector. The private magnet relay 50 again de-energises, and if the line wanted is idle, the private magnet 54 is also de-energised, and allows the side switch to pass to the third position. The wire 4 of the calling line is then joined through condenser 65, under contact of relay 55, side switch 48, by contact *c* to wiper *f* and one side of the called line, and a wire 5 of the calling line, by condenser 66, to the contact of the private magnet 54 and upper under contact of relay 55 to the wiper *d* to the other wire of the called line, and a guarding potential or engaged test is established on the line line 62, outer contact of line switch, wiper *d*, outer under contact of relay 55, contact of relay 54 to upper winding of relay 60—Fig. 7—side switch 44 by contact *c* to battery. Relay 60 is therefore connected across the called line and is energised, and current is fed through the winding of microphone M^1. Relay 60 completes a circuit from earth, through side switch 46 by contact *c*, relay winding 43, line 43, left-hand contact of relay 60 to battery.

Relay 43 is energised, and a retaining circuit is then completed from winding 43 through the middle upper contact of relay 43 through side switch 44 by contact *c* to the battery. Another circuit is also completed by relay 60 from earth by the side switch 46 by contact *c*, line 60, line 63, through the right-hand back contact of relay 60 to side switch 47 by contact *c* to the lower, the winding of relay 42, so that the resistance of the relay winding 63 is cut out of circuit. When the relay 43 is actuated, as described above, it reverses the connections between the called line and relay 42, the circuit now being from earth at the side switch 46 by contact *c*, back contact of relay 60, side switch 47, by contact *c*, lower winding of relay 42, outer upper contact of relay 43, to the *a* wiper of the selector, line 5, through calling instrument back by line 4 and *c* wiper of selector, lower upper contact of relay 43 to upper winding of relay 42 to battery. The reversal of current by relay 43 causes the meter to indicate. The meter contacts closing short-circuits the winding 27, and the meter is retained in the energised position by the local winding 30. Relay 63 is used in semi-automatic systems. Being first connected in series with the lower winding of relay 42 and then shunted by relay 60, additional current is sent to the line, which may be utilised to operate a supervisionary signal or cord circuit.

When conversation is finished and the circuit is opened by replacing the receiver, relay 42 is de-energised. This opens the circuit of relay 49 of the connector and relay 27 of the selector, and both complete a circuit through the associated release magnet—the former from earth and under contact of relay 42, under contact of relay 49, through release magnet winding and contact to battery, and the latter from earth and under contact of relay 26 to the under contact of relay 27, through release magnet winding, and connect to battery. The release magnets attract the "dogs," and thereby release the wiper shafts, which are revolved by the controlling springs, until they fall by gravity to the normal position. In this position the release magnet contacts are opened, and they disconnect the battery. All circuits are broken, and apparatus returned to the normal position of calling. Should the line called for be engaged, there will be a guarding potential on the private bank of the connector. This circuit in the connector just described is from earth at the side switch 46

The contact nearest the winding of relay 52 is also closed, and a circuit is completed from the secondary circuit of the busy signal machine 64, line 64 make contact of relay 52, side switch 48, by contact *b*, bottom under contact of relay 55, through condenser 65 over wire 4 and through the calling instrument and back by wire 5 to the outer under contact of relay 43, upper winding of relay 42, and by common battery lead to the busy signal secondary winding. The "busy machine" primary circuit 66 is from earth through interrupter 67, winding 66, through battery to earth. When the receiver is replaced after the busy signal is heard all the apparatus returns to the normal condition.

DOCKYARD NOTES.

FROM a recent statement in the *Times* it appears that the United States gunboat Dubukue and the ex-Spanish boat Don Juan d'Austria are now serving in the Great Lakes.

A *Central News* dispatch states that experiments are now being conducted at Cherbourg with a small one-pounder dismountable gun to be carried by submarines. It is hoped shortly to equip the submarines of the French navy with this gun, which, when the vessel is on the surface of the sea, will be placed in the bows, in order that the small craft may defend itself against the torpedo boats guarding larger men-o'-war. When the vessel is below the surface the gun will be carried inside the hull.

THE new ocean-going destroyer Forester, built by John Samuel White and Co., of Cowes, has carried out her official trials. Her contract speed of 27 knots was easily exceeded, the mean speed of over 30 knots being attained for a mile run, and just under 30 knots for an eight hours' run. The Forester was launched in December last, and is a sister ship to the Ferret, which was recently delivered to the Admiralty by White and Co. Both vessels belong to the last year's batch of the Acheron class, comprising the newly formed Seventh Destroyer Flotilla. The Forester is 240ft. long, with 25ft. 6in. beam, and 780 tons displacement. She is fitted with Parsons turbines of 16,000 indicated horse-power, and White-Forster patented water-tube boilers consuming oil fuel.

THE two new battleships to be shortly laid down in accordance with the latest Navy Act of the United States are to displace about 28,500 tons. This displacement will be absorbed in carrying ten 14in. guns as a primary armament, and exceptionally heavy armour.

RAILWAY MATTERS.

IT is stated that, by desire of the German Emperor, Herr Gwinner, director of the Deutsche Bank, will give an address on the Baghdad Railway before the Emperor and a number of invited guests in the Upper House of the Prussian Diet shortly after December 8th.

AFTER giving further consideration to the question of the electrification of their suburban lines, the London and South-Western directors see no cause to depart from their decision not to undertake the change until the completion, some two and a-half years hence, of the reconstruction of Waterloo Station and the additions to the number of tracks.

LAST week Col. von Donop, on behalf of the Board of Trade, inspected the light railway connecting Grimsby with the new deep-water dock at Immingham. The question of speed was discussed, and it was agreed, subject to confirmation by the Council, that the cars should travel 12 miles per hour in the town, and 25 per hour when clear of the streets.

IT is reported in the *Railway Times* that efforts are to be made to complete in six years the new National South-Eastern Railway of Mexico, which will connect the United Railways of Yucatan with the central national lines, and will complete a continuous trunk line from El Paso and Laredo, in the northern part of Mexico, to Merida, in Yucatan. The cost is estimated at over three millions sterling.

A TRAIN lighting instruction car has been placed in service by the Pennsylvania Railway for the instruction of workmen. This company has at present eight distinct axle lighting systems, in addition to several arrangements of storage battery equipment. It is intended to send this car to different points where yard electricians are stationed. The equipment of the car consists of a 32-cell storage battery, a 15-kilowatt Curtis turbo-generator, a variable speed motor with control apparatus for driving the several axle generators, and six makes of the latter with regulating equipment.

REINFORCED concrete slabs for screens and partitions at the North Station of the Boston Elevated Railway are made of a 1 : 2 : 4 mixture of Portland cement, granite crusher dust and small granite screenings. The slabs are reinforced with Clinton wire cloth and round rods in both directions. Dowels, projecting at the sides and ends, are cemented into the adjacent slabs by a mortar filling. The slabs are cast flat in a sand mould, and, when firmly set, the upper surface, which is flat, is highly polished ; this gives a finish, it is stated, similar to the best granite or marble. The exterior face is treated architecturally with panels and mouldings and is left in the rough, as it comes from the form with a coating of sand.

ACCORDING to the *Contract Journal*, four short railway lines are to be laid to connect the docks at Leith with the East Lothian and Midlothian coalfields. As a first step a guarantee fund, for preliminary purposes, of £10,000 has been subscribed by the owners of collieries in the district to be served. Parliamentary powers are to be asked for early next session, and in the event of no opposition being lodged from existing railway companies—the North British and the Caledonian companies—the undertaking will be gone about with little delay. No. 1 line will join the Leith Dock Railway lines at the Edinburgh Dock, and terminate at Prestonpans by a junction with the branch railway to Prestonlinks Colliery, a distance of about seven miles. A second line branches off from No. 1 route and goes to Newbattle, with a branch leading off to Inveresk. A separate line will run from the Edinburgh Dock, Leith, into Midlothian as far as Gorebridge. A preliminary survey has been made by the engineers for the new company, and there are no great difficulties to be faced. Powers are being asked to work the traffic on the new railways electrically, and to construct, maintain, and use electric cables, mains, wires, engines, and motor cars.

IMPORTANT new works are in contemplation at Goole, on the North-Eastern Railway's section, and are to be put in hand at once. According to the *Railway News*, it is proposed to widen the line from near the junction of the Goole and Selby Railway to the viaduct over the Aire and Calder Canal and the Dutch River by constructing independent lines on each side, with sidings which will enable the traffic from both directions to be re-marshalled. By a mutual arrangement with the Lancashire and Yorkshire Railway Company, the latter company will receive additional accommodation and better access to the new dock, the North-Eastern giving up a portion of its land on the south-eastern side of their line and receiving in exchange from the Lancashire and Yorkshire a portion of the Potter Grange estate. This will enable the North-Eastern to provide an exchange yard with the Lancashire and Yorkshire for the Goole docks traffic, and it will also provide for the more effective carrying out of the arrangements with the Lancashire and Yorkshire Act of 1902 for the North-Eastern to make a line from the Potter Grange area under the embankment which carries the Goole and Doncaster main line to land and sidings already in its possession at Glew's Hollow.

THE *Railway Gazette* refers to some tests which have been carried out on the New York Central and Hudson River Railroad with a superheater Mallet locomotive—first with, and then without, a brick arch in the fire-box. One of the main conclusions arrived at was to the effect that the data referring to the performance of the boiler with and without the brick arch warrant the conclusion that the application of the arch to this type of locomotive might be expected, with the grade of coal used, to result in a saving of about 11 per cent. Against this it should be borne in mind that the superheater tubes must be blown out at regular intervals, and that the brick arch interferes to some extent with this operation. Also that boiler repairs to all the tubes are to some extent likewise interfered with. These objections, however, are not at all serious, for with the particular type of arch used, which is known as the "Security," it is a comparatively simple matter to remove and replace any part of the arch in order to do work either on the tubes or the tube plate. Six tests were made with the brick arch in place, an average of 25.595 ton-miles being obtained per ton of coal. In five tests without the brick arch an average of 21.899 ton-miles were obtained per ton of coal, or, in other words, there was an increase of 16 8 per cent. in ton-miles per ton of coal due to the installation of the brick arch.

THERE is a growing tendency to adopt oil engines in the Congo for marine and railway purposes, in preference to the wood-fired steam engines employed hitherto. According to the *Times*, the first important step in this direction was the formation of the Cie. Pétroles du Congo, which, by the construction of the 1in. pipe line of 400 kiloms. in length from Matadi to Leopoldville, will be enabled to supply oil to the Lower Congo district, the Congo Railways, and the regions beyond Stanley Pool. The first kilometres of this pipe are now being laid, and the company proposes to create at Ongo-Ongo the necessary accommodation for the storage of 6000 to 7000 tons of oil. Two tanks are already erected, and a number of others are now being constructed in Belgium. Preparations are being made by the Congo Railways for the employment of locomotives fitted with oil fuel on the line from Matadi to Leopoldville. The fuel used will be petroleum residues, and several hundred barrels have already been despatched to the Congo. The railway company has undertaken the erection of storage tanks at Matadi. It is expected that during the early part of next year the Ongo-Ongo tanks will be ready for use, that the pipe line will be completed as far as Matadi, and that the oil fuel will be adopted on the railway in about ten locomotives. Two of these locomotives are at present in use, and the others are now being constructed in Belgium and will be despatched to Matadi shortly.

NOTES AND MEMORANDA.

A SEMI-GRAPHICAL method for determining the regulation of transformers and transmission lines was recently given in the *Electrical World*. The ordinary circle diagram in practice is accurate only when the various quantities involved in the construction are of similar magnitude, and this is very rarely the case. To obtain sufficiently accurate results when considering the regulation of large modern transformers a diagram having a radius of at least 4ft. would be required. The author's graphical method in most cases gives a result of sufficient accuracy. If a higher accuracy is desired the approximate result obtained graphically is substituted in the equation, and so a second approximation is readily obtained.

IT is reported that a new process for the manufacture of artificial diamonds has been discovered by Dr. Werner von Bolton, a chemist in the Siemens-Halske works. The doctor observed that ordinary lighting gas decomposes when exposed to vapour of mercury, and that if the gas is allowed to work on a metallic amalgam of mercury, the carbon contained in the gas is liberated in a non-crystallised form and in crystals of diamonds. As the diamonds obtained were infinitesimal in size, diamond dust was placed in a tube in which gas was dissolved, to act as so-called "mother crystals." Newly formed crystals adhered to these, and the result was a larger but still very small stone. The amalgam used is natrium, which is placed in a glass tube containing a small quantity of diamond dust, and lighting gas is passed through the tube for four weeks. The inventor is now engaged upon the problem of increasing the size of the stones.

INDEPENDENT investigations of the electrolytic corrosion of steel embedded in concrete are discussed in papers read before the Western Society of Engineers and the American Institute of Electrical Engineers. One paper, by Professor Charles F. Burgess, deals with experiments conducted by the author with the object of obtaining quantitative data on the corrosion of reinforcement under various conditions, and the other by Messrs. C. Edward Magnusson and G. H. Smith gives the results of research into the nature and causes of the corrosive process and methods of prevention. Professor Burgess's test specimens were made so as to ensure the corrosive efficiency of current being maintained at the pressure of 8 volts, and from the results obtained it appears that when the blocks were placed in ordinary water a corrosion of from 0.32 oz. to 1.28 oz. of iron per year is possible per square foot of iron exposed, and that a 3 per cent. solution of common salt increases the rate of corrosion about one hundred times. The data for pressures lower than 8 volts can be approximately deduced by the application of Ohm's law.

THE heavy costs of repairing lining defects has been a most important factor militating against the commercial development of electric furnaces, but out of somewhat unfortunate practical experience a new combined lining has been evolved which is said to be giving excellent results. According to the *Temes*, in January, 1908, one of the principal ordnance works in Austria, the Poldihütte Tiegelgussstahlfabrik at Kladno in Bohemia, put into commission a Kjellin induction furnace of a capacity slightly over four tons. The furnace was mounted on a carriage with provision for rotation in either direction about a vertical axis. The body was therefore subjected to very considerable vibration, which resulted in frequent cracking of the magnesite lining to such an extent that renewal was necessary after some forty-nine charges at the most. The metallurgists of the firm therefore experimented with combination linings to such good effect that the average durability during 1909 was 200 charges per lining. Progressive improvement continued in the following year, until in the third quarter of the present year one lining lasted for 491 charges. It is especially interesting to note that no repairs whatever were carried out in the lining at the slag line.

IN a paper read before the American Electrochemical Society at its Toronto meeting, Mr. Charles V. Slocum reviewed the use of titanium alloy in iron and steel. He states that titanium alloy is best added to the ladle of steel after tapping from the furnace and before the slag begins to run. For open-hearth steel the supply should be placed near the ladle and shovelled in precisely as so much coal. For soft steel an addition equivalent to 0.03 per cent. titanium is sufficient to make the steel more ductile. Larger quantities are of increased benefit, but cannot always be added because of the carbon content and also because of the density imparted to the steel, which increases as the proportion of alloy is increased, and therefore is not always desirable. In high carbon steels this increased density is desired and more alloy is used. The addition of the alloy permits the use of a considerably higher carbon content without increasing the brittleness, and several railways are now using as much as an equivalent of 0.10 per cent. titanium or more in securing tough durable rails. In the crucible practice the best results have been obtained by adding the titanium alloy to the pots before they are removed from the furnace, giving more time for washing and deoxidising before teeming.

ACCORDING to the annual report of the Chief Inspector of Explosives, Victoria, Australia, it would appear that of the three factors which control the production of fumes, too much blame is allotted to (1) the composition and character of the explosives, and not enough to conditions, which equally control the fumes produced by explosion, namely, (2) the nature of the "country" in which the shots are fired, and (3) the methods of preparing and tamping the charges. Of these factors, the first—a constant for each authorised explosive—is the only one which is independent of the mine. The second factor—the "country" in which the shots are fired—influences the products of combustion owing to the presence of substances such as graphitic shales, sulphides, &c., which may be regarded as always present in greater or less degree, and which react with the oxygens of the explosives, causing the formation of carbon monoxide and other objectionable gases in quantities depending on the amounts of oxidisable minerals present and the degree of pulverisation that has taken place. The third factor is entirely a personal equation, and, in spite of instructions given by mining inspectors, managers, and agents representing the various manufacturers of explosives, remarks the inspector, is probably the most fruitful cause of bad fumes.

LUBRICATING oil, when it reaches the hot walls of a cylinder, is so reduced in viscosity that it rapidly runs down to the lowest point of the cylinder, and is either blown away through the exhaust or carried off by the drain pipe. The oil then is carried by the steam chiefly in the form of fine spray, and only to a certain extent as fine vapour. In the case of saturated steam the oil is carried as thin films of oil surrounding the drops of water. The usual method of separating the oil is, of course, to pass the steam through a baffle plate separator, the water and oil being collected and run off together. The amount of oil carried away by the exhaust steam is only one part in five or ten thousand, and hence, however high may be the boiling point of the oil, a considerable part of the oil carried by the steam must necessarily be vaporised. This vaporisation is, moreover, greater on account of the fact that lubricating oils are a mixture of hydrocarbons of various boiling points, the lowest boiling constituents of which are readily vaporised at the temperature of the steam. It is evident, therefore, that separators placed in the steam pipe cannot remove all the oil, however well they may be designed. According to the *Iron and Coal Trades Review*, some tests made at the Massachusetts Institute of Technology on baffle plate oil separators show that the amount of oil separated out in this way is about 75 per cent. of the total oil contained in the steam. The remaining 25 per cent. of oil goes on to the condensers, and is precipitated in the water in the form of very minute globules.

MISCELLANEA.

CONSIDERABLE interest attaches to the find of uranium ore in South Australia. The Commission of Crown Lands has received from the Government geologist, Mr. H. J. L. Brown, a report on the occurrence of uranium ores and other rare metals on the ground held under right of search by the Radium Extraction Company, of South Australia, near Mount Painter, in the Flinders Range. The uranium ores have been found in several localities. The report deals in detail with the ores found in each of the workings, and goes on to state that the fact that ores of uranium have only been found to a very limited extent in other parts of the world makes the discovery in South Australia of great importance, as uranium is the chief source from which radium is derived. Several localities have already been discovered within the radius of a few miles, and others within all probability will be found by further testing. The presence of ores carrying niobium, monazite, and other rare metals associated with the uranium ores in some of the localities add a value to these discoveries.

WATER purification at Minneapolis will be carried out in a plant designed to afford unusual flexibility of operation, required by the rapidity and extent of the changes in the character of the Mississippi River water which will be used. For this purpose the plant has been provided with cross connections and by-passes to an unusual extent, and, in addition, many devices of an unusual nature have been introduced to increase the efficiency of the works. The water is to be coagulated with sulphate of alumina, lime being added when necessary to secure the required alkalinity ; it will then pass through rapid filters and finally be sterilised with hypochlorite. A description of the plant given in the *Engineering Record* points out some of the novelties of design, such as the use of concrete batch mixers for slaking lime, an adaptation of grain spouting devices for delivering chemicals from storage bins, means for opening metal drums of hypochlorite while they are entirely submerged in water, and motor-driven propellers for agitating the solutions of chemicals so as to secure a mixture of uniform strength.

THE demand for electricity in New Zealand for industrial purposes, such as for factories, mining, tramways, street lighting, and for domestic lighting, heating, and cooking, is increasing constantly. The public has become so educated to electricity that the need for its cheap development by water power is well recognised by local government authorities, who now feel that unless they are prepared to permit private capital to establish water-power works, they can no longer refrain from committing themselves to the necessary expenditure and risks. At present, according to the American consul on special service in New Zealand, 1,320,000 units of electricity are sold annually for electric lighting in Wellington, 742,000 in Dunedin, and 369,620 units in Christchurch. In Auckland electric lighting has just been introduced. In all these cities, except Dunedin, electricity is now produced from coal. Electric street lighting is already fairly well developed in Wellington and Dunedin, 562,000 units being used last year in Wellington, and 102,000 units in Dunedin.

THERE are many mines with wet shafts, at the foot of which the falling water has to be collected and pumped to the surface. That this power can be profitably utilised is shown by the experience of the Bowhill Coal Company, which, according to the *Iron and Coal Trades Review*, has applied it to ventilate the workings of the lowest seam in one of its pits. To collect the water falling down the downcast shaft, the tubbing was cut and a ring was fitted round the shaft. This ring collects the water and guides it into a tank placed in a lodgment made to receive it. The ring and tank are 295ft. above the bottom of the shaft, so that a working head of about 295ft. is obtained. A pipe from the tank conveys the water to a Pelton wheel of 4ft. 6in. diameter. This wheel drives a 60in. diameter, double-inlet, Sirocco fan, capable of dealing with 60,000 to 90,000 cubic feet of air per minute at 1in. to 3in. water gauge. Should it be necessary at any time to stop the fan, a by-pass valve is provided to allow the water to be discharged directly into the sump from which the main pumps draw their supply.

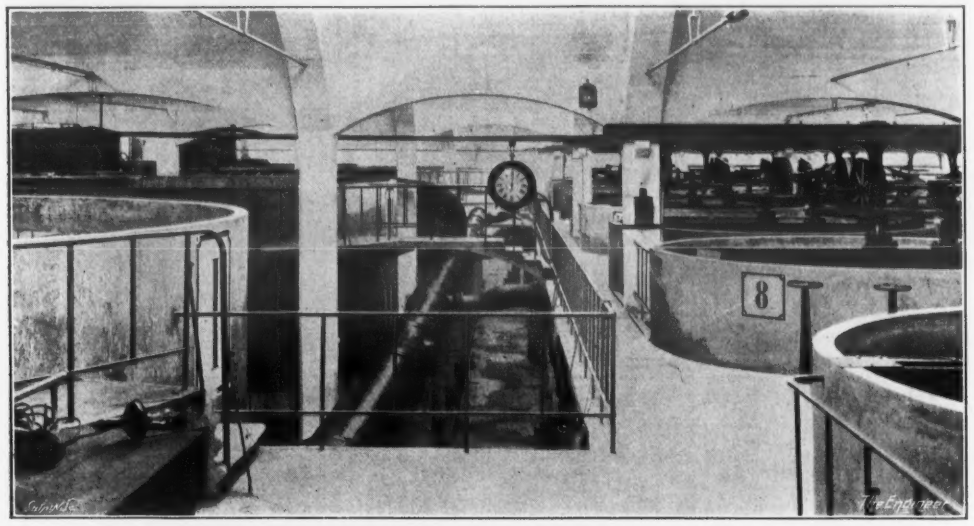
THE increased output of tin from the mines at Kotiou, in Yunnan Province, which has been expected as a result of the introduction of German machinery and German technical supervision, is already manifest, according to the American Consul-General at Hongkong. The total exports of tin from China in 1910 amounted to 14,351,108 lb., as compared with 9,931,775 lb. in 1909, and 10,635,345 lb. in 1908, the high output for the last-mentioned year being due to interruption in export due to floods in 1907. The export of tin from the Kotiou mines is practically all to Hongkong, the output of these mines accounting primarily for 96 to 98 per cent. of the exports of all China, and actually accounting for more than that proportion in view of the fact that much of the small balance exported from other Chinese ports is Yunnan tin, originally received from Hongkong and re-exported. About half of the tin received in Hongkong—about half of China's output of tin—is re-exported to Chinese ports and consumed in China. However, all of the increased output of Chinese tin is going to Europe and the United States, as Chinese ports took less tin last year than the year before.

AT a meeting of the Illuminating Engineering Society held on November 17th in the lecture-room of the Society of Arts, Dr. H. R. B. Hickman read a paper on "The Design of Motor Car Headlights." The essential requirements that headlights should fulfil were laid down as follows :—(1) The road should be well illuminated over such a distance that time is given to stop before the car reaches an obstacle ; (2) this illumination should extend to the sides of the road near the car as well as far ahead, whether by means of the main beam or independently, in order to avoid dark areas near the car ; (3) the lights should indicate clearly the extreme width of the car as well as its position ; (4) the space for a few yards behind the car should be illuminated, but not too brilliantly ; (5) no part of the main beam should exceed a height of 4ft. 6in. ; (6) the headlights should turn with the steering wheels, or, until the curious regulation forbidding swivelling headlights is abolished, a sufficiently divergent beam should be used to enable corners to be taken with safety ; (7) the apparatus should be light and not liable to get out of order, and should not require any mechanical devices to take the attention of the driver ; (8) good penetrative power is required in foggy weather.

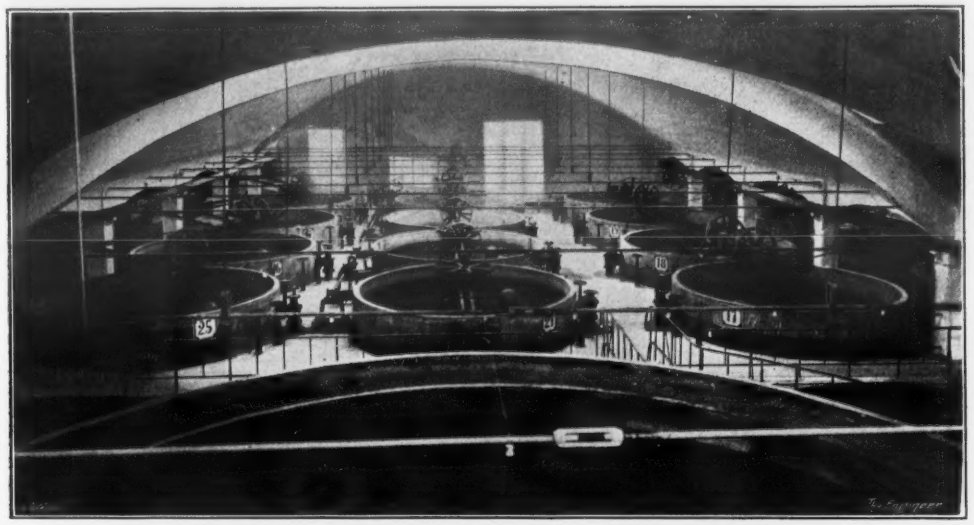
A POINT which is now agitating the aeronautical industrial world is one that is down for discussion on the agenda of the International Aeronautical Federation, which meets at Turin on November 25th. Briefly, states *Nature*, it is that it should be made compulsory for aeroplane manufacturers to submit a specimen machine of each type made by them to the representatives of the International Aeronautical Federation—*i.e.*, the Aero Club—in their respective countries in order to receive a certificate of soundness of construction. Our contemporary points out that at the present time such a rule is absurd, for the chief reason that, for instance, in this country only the manufacturers themselves are capable of passing an expert opinion on the merits of any machine submitted. Furthermore, if carried out, it would shift responsibility from the manufacturers to the aero clubs, which are privately organised bodies, and it would tend to confine the manufacture of machines to certain standard types and close the way to originality and progress. Manufacturers are already up in arms in this country against this extraordinary measure, which, it may be stated, has its origin in France, and it is to be hoped that the delegates of the Royal Aero Club will receive instructions to oppose it to the utmost. In such attitude they will, no doubt, have the support not only of the club they represent, but also of the German and Italian organisations.

WATER PURIFICATION WORKS AT ST. PETERSBURG

(*For description see page* 560)



SETTLING TANKS AND FILTERS



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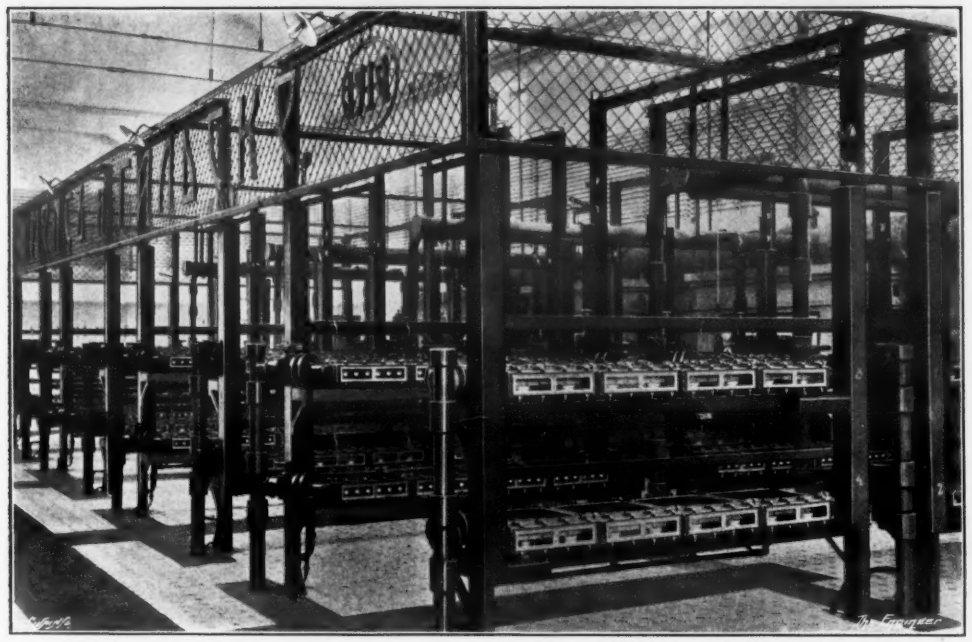

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MEETINGS NEXT WEEK.

(*See "Forthcoming Engagements" page* 574.)

THE ENGINEER.

DECEMBER 1, 1911.

The Canadian Navy.

A CABLEGRAM from Ottawa announces that the new Premier, Mr. Borden, has just given the final blow to a long-cherished scheme for providing the nucleus of a Canadian navy as formulated by the late Laurier Government. This has been anticipated for some time, and now, rightly or wrongly, it has been definitely settled that the Dominion is not to proceed with the navy scheme, as far, at any rate, as it involves building these ships in Canada. The Laurier proposal provided for an expenditure of £10,000,000 spread over ten years; this was to cover the cost of building in Canadian yards, with Canadian materials, four protected cruisers of the Bristol type, and six torpedo-boat destroyers. It was intended that this new construction should take place in newly laid down shipbuilding yards on both Atlantic and Pacific coasts, to be organised by existing British firms or syndicates of undoubted repute. Arrangements were made provisionally for yards to be established at Sydney, Cape Breton on the Atlantic side, and at Esquimalt in British Columbia on the Pacific side. The Sydney yard was to have been operated by the British-Canadian Shipbuilding and Dry-dock Company, a syndicate in which the Fairfield Company, Govan; John Brown and Co., Clydebank; and the Coventry Ordnance Works were represented; while on the Pacific side Messrs. Denny, of Dumbarton, were to establish a yard at Esquimalt, both these yards being furnished with all the most up-to-date appliances. In addition to this, large graving docks and repair works were to be instituted at Montreal by Vickers, Limited, of Barrow-in-Furness, and there was talk of other large dry dock schemes in the neighbourhood of Vancouver. Such a programme, if carried into effect, would not only have provided the beginnings of a navy, but the beginnings of a great national industry would possibly have found a permanent establishment. It is just here, however, that there is, perhaps, a source of weakness in the proposal, for the ships could not in the nature of things have been available for a long time to come.

The new Government repudiates most strenuously the suggestion of the late Premier that the present Cabinet includes members who are opposed to naval defence in any form. Mr. Borden says, on the contrary, that the late administration proposed to do too little for Imperial defence, and to do that little in a wrong way. If the main intention be to strengthen the hands of the Mother Country by providing warships which will be available for her defence in time of need, then the most effective way is to order at once a number of up-to-date vessels from those estatablishments which are fitted to supply them complete at a date not much later than the keels of such vessels could be laid in new Canadian yards. From the Imperial point of view this is sound policy, and the Laurier proposal undoubtedly suffers from the fact that ten years hence cruisers of the Bristol class, if constructed in Canada, would not only be much more costly than British-built ships, but would also be already on the way to becoming obsolete in pattern; this would defeat the avowed end of the scheme, even if it succeeded in establishing a new industry. It is probably impossible to combine the two ideas successfully in one scheme, as so often happens; if an immediate aid to Imperial defence be intended as the end of the proposition, then placing of orders for war vessels at once is the logical conclusion; if, however, the foundation of a new industry is desired, by all means let it be done, but not under the name of Imperial defence. This seems to be the attitude of the new Government, and while the logic of it is unassailable, there will be much disappointment both in Canada and at home at the collapse of the scheme. The firms involved in the negotiations must have spent considerable sums in investigation which can have now no adequate financial return, unless, as is only fair to expect, these firms have some measure of preferential consideration when tenders for the new ships are sent in. There is, perhaps, a midway course which might be made to combine both ideas without involving construction of ships that would not be up-to-date on completion, that is to place orders for a number of cruisers at once in home-country yards, and to lay down torpedo-boat destroyers, which would not take so long to build in new Canadian yards as originally proposed; for it must not be forgotten that possession of shipbuilding yards and docks, in which construction or repair of war vessels may be undertaken, is sometimes as valuable an asset as the possession of ships themselves. The unfortunate thing is that these yards could not be of any material service from an Imperial point of view for some time to come.

The new Government cannot be charged with failing to fulfil the obligations of its predecessors, for the carrying out of the scheme was contingent upon the continuation of the Laurier administration in office; and it was well known that its proposals on this matter met with considerable opposition last year. Mr. Borden proposes to reconsider the whole scheme, to submit proposals to the people of the Dominion by referendum, and to consult with the Imperial Government as to the best means of "doing their duty as citizens of Canada and of the Empire." This will probably end in the placing of orders for new construction in the home yards at no distant date, as has been done by Australia and New Zealand, which countries are already far ahead of Canada in contributing a share as factors in the Empire to its defence.

Research.

ONE of the latest additions to the curricula of technical schools is research work. Research may be regarded as the marshal's baton which every student carries in his satchel; it represents the highest ambitions of the student's breast, and it is held to confer more honour than the University degree. To be a research scholar means to the student's mind to be engaged on new and original investigations, and it places him on the same platform as Faraday, Joule, Ohm, Boyle, and the scores of other great people who have discovered new laws and added new definitions to our dictionaries.

Of the educational value of research no one can be in doubt. Properly and honestly conducted, there is probably no higher training for the mind. It leads to great precision of thought and to much experimental dexterity. Moreover, though narrow in itself, it is but the opening to a large field, and in the pursuit of it the area of knowledge opens wider and wider. It calls out, too, all the student's powers of observation, the most useful of all the faculties he acquires in the laboratory. But when we have said all this for technical college research work we have summed up nearly all that can be rightly claimed for it. Too often the student gets a wrong idea of the value of his research work. He forgets that its object is to train him, and that any other value it may have is, in ninety-nine cases out of a hundred, practically nil. Too often it is undertaken with the hope that it may bring honours rather than knowledge. The student imagines that he is doing something great for the world, and starting with an exaggerated opinion of his own importance, nourishes bitterness in his heart against those who estimate the value of his work by the accepted commercial standards. We should be the last to discourage the ardour of youth, but we venture to suggest that it would be better for his own happiness if his professors insisted constantly on the fact that college research work is only a form of training, and that its value, from any other point of view, is generally insignificant. When the student in the art school gives up drawing from the antique and begins to study from the life, he is in a parallel position to the student who leaves the ordinary cut-and-dried laboratory work on what he has trained his 'prentice hand, and takes up research work. But the art student never supposes he is making pictures, and he is careful enough, as a rule, not to let the world see what he does. He recognises that he is only studying, only making preparation for pictures he may paint some day. The research student does

not take this view; he believes that at great sacrifices on his part he is conferring a benefit on the world, and as soon as he has amassed a quantity of figures, he takes—alas too often with the encouragement of his professor—the first opportunity of rushing into print. It is there that he makes the mistake. "In most cases," said Professor Marchant some time ago, "it is the carrying out of the work that is of the greatest value, and not the result. A great many papers are published not, mainly, in engineering subjects, of very problematical value." Now and then a student does do some really useful work, but as a rule the undeveloped state of the mind at college age and the limitations of the plant at his disposal render work that should be dignified with the name of research out of the question. Indeed, it is a pity that the word should be put to such a use. That we should pair, by applying to them the same name, an inquiry into the nature, cause, and prevention of, say, cancer and the leakage past the regulator valve of a locomotive is absurd. All day long and every day engineers, chemists, physicists, &c., are engaged in testing, experimenting, and inquiring, but they look upon it as a bit of the daily routine, and do not exalt it by calling it research. The student replies, "Yes, they are doing it for business, I am doing it in the cause of science. They look for an immediate return; I am content to leave the return to chance." Precisely, the student who measures the resistance of ship-shape models in the college tank calls it research, whilst the men who are settling the forms of our battleships and merchantmen call it daily routine. But that is only a single example of what is happening in all directions. A youth makes a number of tests of different steels, and is honoured with the name of research student, whilst another on 30s. a week is doing the same thing day after day with higher accuracy and equal intelligence and is known as the works chemist.

Do not let it be supposed for a moment that we are protesting against what the colleges call research work. Far from it; we believe that there is no better use for a laboratory, and we should be glad to see more real experimental inquiry and less routine. We should like to see students discovering laws instead of proving them. But we do think the word research is being sadly misused, and that its misuse has a prejudicial effect on the student. We should like to see the true position of student research work recognised, and more reticence encouraged on the part of its votaries.

Railway Economies.

THE demands of the men who work our railways all resolve themselves, when the uniform of sentiment decorated with political scraps is stripped off, into a determination to get higher pay and shorter hours. The shorter hours represent bigger wages, not necessarily per man, it is true, but, at all events, a larger total expenditure by the companies. Far be it from us to say that the aspirations of the men are not legitimate. Until the Socialist millennium comes, and no man, woman, or child wishes to have more of anything than does anyone else, such aspirations will always be not only legitimate, but meritorious; in the sense that a desire on the part of every man to have more, or to be more than he is now, has been the cause of progress, the seed from which has grown the world-wide spread of civilisation. But when this has been conceded we have to remind the clamorous crowd that wages must come from somewhere. They are not created by the directors and chairman of a company. They are, in point of fact, provided by the travelling public, of whom by far the greater number are themselves wage earners. The theory is that the traveller does not pay more than he ought, but that the distribution is wrong, the profits being so large that the shareholders and principal officers are much over-paid. It would, of course, be waste of energy to attempt to upset this view by bringing forward figures. Obviously, the only way to get more money is to augment fares and rates, or else to reduce working expenses. The first will be found a dreadful way out of a difficulty. The principal obstacle to the second is "the necessity for keeping up appearances," a well-known competent cause of the ruin of families and commercial undertakings from banks downwards. To effect economies the railway companies must give up a good deal which the travelling public may not wish to part with; and the wayfarers may find their luxuries curtailed. But it is possible to continue to live with beer or claret as beverages failing champagne; and we might still get on in this country if some continental methods of working traffic took the place of those to which we now point with pride as the most luxurious as well as costly in the world.

We have no hesitation in saying that there is not a locomotive superintendent in the kingdom who will not join in the asseveration that passenger trains are underloaded. "If only traffic managers would half fill them we should be well content," is a unanimous cry. Our rolling stock has become enormous in its dimensions. It was stated by Professor Dalby at the British Association last year that the Scotch express trains on the West Coast increased from 100 tons in 1864 to 250 tons in 1885, and to 450 tons in 1903, while average speeds increased from 38 to 52 miles an hour. It would seem that we have here reasonable grounds for assuming that an economy might be effected by reducing the dead weight hauled. In a modern Scotch dining-car express the net weight is about 340 tons, and seats are provided for 240 passengers, exclusive of the dining-car, or nearly 1.5 ton per seat. But not so many years ago the dead weight per passenger was only half this. When we come to consider, not the dead weight per seat but the dead weight per passenger, the case is much worse. If the train is only half filled the dead or unpaying load is doubled. This hauling of dead weight represents dead loss in two or three ways. The capital cost of the train increases in more than the same proportion, and so does the maintenance outlay. The wear and tear, both of rolling stock and permanent way, also go up. It is useless to argue the point. There are two ways in which economy can be effected. One consists in filling the trains better. A lesson should be taken from French and German practice. To do this, let the passenger traffic management begin with the guards and ticket examiners, who have the allotment of seats in their own hands. We can do no more than hint at possible economies. Again, enormous sums are now spent on the upkeep of permanent way. This is partly a consequence of the running of very heavy, high-speed trains. But it is worth considering whether the outlay might not be reduced without risk of any kind. Can it be argued that the last month of trustworthy service is got out of each sleeper? We think not. Is it true that "the plate-laying" bill is no larger than it need be? All we have to do is to compare one railway with another to see that some standards of efficiency and luxury are much higher than others, yet there is the same immunity from disaster. Is not the luxury very largely the result of "a keeping up appearances" policy rather than of a demand by the public? Is there any reason to think that the suppression of the second class has brought about a reduction in income at all like the saving secured by the change? Of course not.

Turn again to the cost of working passenger traffic on some lines as compared with others. Contrast, let us say, the army of porters on the platforms at Euston or Paddington with the meagre troop at St. Enoch's or Waverley. How does Scotland manage with so few? It must be that traffic managers in this country have made themselves well acquainted with the methods of working pursued in France and Germany. They know consequently how far their methods make for economy. For example, instances may be named in which an economy of as much as 20 per cent. in the cost of working trains has resulted from no more drastic change than was represented by taking care that at least four-fifths of the seats were filled. It remains for the traffic superintendent to say how far it is possible to insinuate French or German or Italian economies into English practice, a task, perhaps, none too easy. When cabs to protect foot-plates were first introduced from France on the Eastern Counties Railway the drivers and firemen struck. To assume that our methods are the best possible is beyond the bounds of reasonable faith. Changes will be forced on the railway world. The travelling public is, no doubt, quite satisfied to dispense with a few trains, and to be content with a smaller proportion of empty or nearly empty compartments. But it will not be satisfied to pay higher fares; and a substantial rise in the cost of moving goods and minerals will certainly evoke howls of desperate remonstrance from the trader.

One point seems to be overlooked by the men, and, indeed, by the public. Railways are overstaffed now. One of the first effects of a win by the men will be—must be in short—the discharge of numbers of hands. This could not be met by a strike. Much that is done now by hand could be done by mechanism. If once the railway companies are put upon their mettle, they will invent new ways to reduce expenses. After all, the strikers may find that apparent success would mean real disaster.

American Patents.

NATIONAL characteristics beyond question affect the work of invention. In large measure they also modify machine design. Just as the furniture and utensils of a province or a country are different in size, form, colour, and even purpose, from those of other countries, so are their inventions. The psychologist might find in such facts a very interesting subject for study. Most mechanical engineers of experience can tell almost at a glance in what country a steam engine of any kind has been made. Three locomotives, French, American, and English, intended to do the same work, will bear to each other little more than a close general resemblance. Although the connection between patents and actual machines is by no means so complete as is commonly believed to be the case, yet there is some. Patents do in a way indicate the current of invention. It is constantly argued that American manufacturing engineers get ahead of ours, because patents are so cheap and so easily obtained in the United States. Obviously this can easily be tested. We have only to ascertain what it is that is patented to settle the point.

In the first place we find that with a population nearly double ours, the number of patents—about six hundred per week—is by no means largely in excess of those secured here, and in the second place an examination of these patents will suffice to show that there is little in the small fee argument. So far as can be seen, the cost of patents bears no relation whatever to the number of inventions that prove useful. In any case these must be few. In this country an enormous proportion of the inventions patented are worthless. This proportion is exceeded in the United States. American patents, it used to be said, all referred to methods of holding cow's tails while they were being milked, or to apple parers. In other words, this simply meant that an agricultural population developed agricultural mechanism. To this day we find the same tendency at work, though on somewhat different lines. None the less are many inventions referring to farm implements fatuous to a degree. In this country men patent improvements in steam cultivation and such like—matters of some dignity so to speak. In the States dozens of patents are obtained for draught equalisers, that is for an arrangement of swingle-trees, which will equalise the draught for three horses pulling abreast. Not one of these is really better in any respect than the very old and well-known method, by which one horse pulls at the long end and two at the short end of a main swingle-tree. We find elaborate systems of cords and pulleys, and springs and toothed wheels patented to secure the same end. All this seems to be fatuous; but it must be futile also. Let it be supposed that one of the new methods is really better than the old. How is the inventor to reap any benefit? Can he traverse the length and breadth of the country, visiting every farm in the search for infringers? Nothing perhaps is more remarkable about patents than the way in which they are taken out without a thought as to the means by which they shall be made operative for the good of the inventor, or anyone else.

This multiplication of patents with the same object is by no means confined to agricultural machinery. We find it at every turn. The tendency to patent along the same lines presents a curious phenomena. In a single week possibly a dozen patents will be obtained for, let us say, box-nailing machines. Then weeks or even months will pass without one. It is not as though all the patents came from a single town or district. On the contrary, the inventors live not infrequently a thousand miles or more apart. Nor does it appear that any demand for box-making machinery has suddenly sprung up to stimulate invention. We have already referred to the taking of many patents with the same object. The practice is pushed a long way in the United States. There must be hundreds of patents for "non-refillable bottles." Automatic car couplers are to be found in multitudes. Gas producers are in legions. As for elastic wheels, most of which would be mud bound in an hour, they are extremely popular as a subject for patents. Another phase of this practice is the taking of patents apparently without any object at all, novelty of any kind being prominently absent. Thus we have a bunsen burner, the invention (?) about which consists in turning in the rim of the outer tube to an extent scarcely perceptible. Certain things can be done, and are done now in half-a-dozen ways all about equally good. We find yet another patented. This is peculiarly manifest in comparatively novel processes, as, for example, in reinforced concrete, special groupings of rods are

patented. Any other grouping, or no grouping at all, would do just as well, and in any case no skill is required to avoid infringement, and leave the patentee out in the cold. We do not say that this policy is peculiar to the United States or to any other country. But it is not pushed to the same extent.

There is a marked distinction between the inventions of Americans and those of foreigners patented in the United States. The latter, with few exceptions, are more important and possess more weight and solidity, so to speak. This is not remarkable, however, because trivialities are not likely to wander far from home. As in other countries, we find really noteworthy patents few and far between, and in most cases they are taken up and worked by companies of position and wealth. It would be quite possible, if it were worth while, which it is not, to classify the valuable inventions made in the United States. They are in the main electrical, metallurgical, or in some way connected with steam. There is a multitude of repetition patents; those, for example, for triple valves for air brakes must number hundreds.

The whole theory and practice of invention constitutes a subject full of interest. Why does a man rush to the Patent-office the moment he has invented something? We doubt that it is the desire for gain pure and unmixed; for most people who speculate assure themselves that they have chances of getting their money back, this belief being based on the result of some inquiry. The inventor never waits for any information of this kind. It seems that inventing and patenting is a species of disease, and it appears to be rather more prevalent in the United States than it is elsewhere. In the old days it used to be pointed out that the entrance to the British Patent-office lay between the offices of the Receiver in Bankruptcy and the Commissioner in Lunacy. It is certain that the lines of invention popular in the United States are not coincident with those prevailing here. In the United States patentees never seem to ask themselves whether the thing patented is wanted or not, or whether it would satisfy a want if that want existed. No doubt the futile practices of the inventor are in some measure due to the small fees charged by the Patent-office, and to ignorance of the fact that a United States patent is barely saleable until its validity has been fixed by a court of law. Higher fees probably induce more caution in this country, and on the whole a higher class of patent is the result.

THE GERMAN INSTITUTION OF NAVAL ARCHITECTS.

No. I.

THE thirtieth annual meeting of the Schiffbautechnischen Gesellschaft was held in the Technische Hochschule, at Charlottenburg, under the presidency of H.R.H. the Grand Duke of Oldenburg, on the 23rd, 24th, and 25th of November. The first paper was one by Direktor Bredow on "Marine Wireless Telegraphy Installations." Beginning with a review of the past career of the German Telefunken Gesellschaft, the author enumerated the stations possessed by it, and gave a number of diagrams showing the results now obtained by its system in the sending of messages. Ships, with their comparatively small receiving apparatus, had received communications at distances of more than 3000 miles, the best results being attained by night. Incidentally, Herr Bredow said he was now allowed to make the announcement that the Nauen Tower had been increased in height from 328ft. to 656ft., and, next to the Eiffel Tower, was now the highest in the world. Its antennæ also had been proportionately extended. The apparatuses fitted on a number of war, passenger, and lightships were described in detail, and the advantages of such installations emphasised. A method of determining the position of a vessel in a fog by means of messages received by her from two stations on shore was explained, and Direktor Bredow expressed the hope that further developments would be made by international co-operation. A vote of thanks was accorded to the lecturer.

The next paper dealt with "The Oil Motor in the German Sea Fisheries," and was presented by Professor Romberg, of Charlottenburg. The author emphasised the importance of the fisheries to Germany both as a source of food supply and as a training ground for seamen, and regretted that the engineer played so small a part in the construction of the boats and equipment belonging to them. The fish caught by German fishermen in the year 1910 was valued at about £1,672,000, and that which entered the country from abroad at about £3,617,000. The German fishing population was much smaller in proportion to the coastline and the general coast population than that of Denmark, and since the inland districts were beginning to consume more fish there was a large field for the expansion of the industry. The first trial of an oil engine in the German sea fisheries was made in 1902. In Scandinavia it had then been at work for about ten years. Originally applied to the winches, it had gradually been adopted as a motor for the driving of the boats themselves.

The German Sea Fisheries Association, which had made strenuous efforts to raise the industry, had at first put its faith in the light oil enginesas used for motor cars. These, however, had proved unsatisfactory on account of the fires and explosions which they occasioned, and of their unsuitableness for the rough usage to which they were subjected at sea. The Danish motors, which were rough, heavy, and relatively cheap, had meanwhile been achieving success, and many of them were now imported. The German Sea Fisheries Association, assisted by a Government grant, then offered a prize for a successful German motor, which elicited designs suited to the conditions of the work, and it was thought that home firms of engineers would be able to supply the needs of the fisheries. The points specially aimed at in the designs of motors for the smaller boats were simplicity in parts and in operation, cheapness of engine and oil used, and moderate speed of working. In view of the ballast which these boats usually carried, smallness of weight was of less importance, but it was desirable that the motor should take up a minimum of room. The endeavour was made to raise the pressure in the cylinder as much as possible, and there was a tendency to adopt the two-cycle in preference to the four-cycle system.

For horse-powers between about 10 to 15 one cylinder was employed, and up to 30 horse-power, which was looked on as the limit for small boats, not more than two were favoured. Passing to examples of actual engines, Professor Romberg then gave particulars of the "Brons" motor of the Gasmotorenfabrik Deutz, which, he said, had two cylinders and belonged to the 4 cycle order. The first stroke drew the air for combustion into the cylinder, the second compressed it to about 27 atmospheres. Fuel and air mixed in the ignition chamber, which opened into the combustion chamber, exploded under the pressure, whereupon the whole of the fuel passed through the openings in the ignition chamber into the cylinder. This process was followed by expansion and exhaust strokes, as in the case of the 4-cycle motor proper. The sytem was less complicated, but also less efficient, than that of Diesel. The parts, including heavy fly-wheels, had to be stronger, and therefore heavier, and the cost of production was greater. For engines that exceeded 30 horse-power the system ceased to be economical.

Amongst other peculiarities of this design might be mentioned the lubrication of the cylinders by means of pressure oil, the construction of the cylinder cover in two parts, the arrangement of both the inlet and the outlet for the cooling water in the latter, and especially the ignition chamber. Situated at the bottom of the plug-like casting through which air and oil were admitted, this organ, which served at once as gasifier and igniter, projected into the cylinder. Part of the mixture of air and oil in the chamber passed through small perforations in its bottom, and at the end of the compression period ignited in the cylinder. By the force of the explosion, which then extended into the chamber, the rest of the oil in the latter was transferred to the cylinder. The governor was so arranged that it came into play only when exceptionally high speeds of revolution were attained, as with uncoupled shaft, &c. The weight of the 24 horse-power motor was given as 8140 lb., that of an 8 horse-power motor by the same makers being 3520 lb. A description was given of the motor brought out in 1892 by Hornsby-Akroyd, which had been further developed in Scandinavia, and was now extensively used in small fishing craft. The great advantage of this motor was considered to be its simplicity, which fitted it for the rough usage of the fishing boats. Its chief disadvantage lay in the circumstance that the ignition chamber had to be heated for ten to fifteen minutes by means of an oil lamp before the engine would start. The not very high efficiency of this motor was considered to be less harmful than the stoppages which would ensue with a complicated engine of high class in untrained hands. Hot-pot motors, both on the 4-cycle and on the 2-cycle system, were in use in the German fisheries. A description was given of an 8 horse-power hot-pot 4-cycle motor by the K.M.A.G., vorm. C. Daevel, of Kiel. The weight of the motor was given as 3168 lb. A peculiarity of this engine was that, to prevent excessive heating of the cylinder, cooling water had to be introduced at regular intervals, for which manipulation the fishermen had not always the time.

A description of a 2-cycle motor of 6 horse-power on the same lines by the M.A.G., vorm. Ph. Swiderski, of Leipsic-Plagwitz, then followed. The single cylinder had a diameter of 7in., with a stroke of piston of 8¼in. The normal speed was 375 revolutions per minute, the normal output 6 and the maximum output 9 horse-power.

With regard to the larger fishing craft the author referred to Messrs. Frerichs and Co., of Osterholz-Scharmbeck, as the first German firm to engine a herring boat with a motor of 90 horse-power. This venture was not yet concluded, and no data could in the meantime be given. Particulars were then given of a 75 horse-power 4-cycle Diesel motor by the G.M.F. Deutz, of Koln-Deutz. This motor, which had three cylinders, was fitted in a vessel belonging to the Biological Institution in Heligoland. It was considered to be a practicable engine for sea-fishing purposes. The author then passed on to the consideration of the whole installation of fishing vessel and motor, and pleaded for the application of more intelligence, especially in the designs of the boats themselves and their equipment. In conclusion, drawings of boats and particulars of results of tests were given, the latter of which in general spoke well for the motor system.

Geh. Reg-Rat Professor Oswald Flamm, who opened the discussion, said that the part of the very interesting exposition of the lecturer which had chiefly interested him was that which bore reference to the motor to be supplied by the Deutz Company for the vessel of the Biological Institution in Heligoland. As he had been in a position to communicate to the meeting a year ago, he was himself entrusted with the construction of this vessel. In the course of the design a great deal of consideration had had to be given to the question whether a steam engine or an oil motor should be adopted as the source of power, and some particulars of this would no doubt be of interest to the meeting. In this vessel they had not to do with the ordinary work of fishing only, and the use of very tender and soft nets for the capture of all sorts of marine animals made it imperative that the speed of the motor should be as low as possible, so that the vessel might be enabled to slow down easily from 7 knots to half-speed. A further circumstance which caused difficulty was the necessity that existed for the keeping in constant motion of a small rotary pump for the promotion of a circulation of the water in a series of tanks carried by the vessel. To keep the marine animals alive, he explained, it was necessary that these should be kept in constantly circulating freshly supplied sea water. In view of this a pumping plant had to be provided which was easily kept going so long as the motor was at work. When this was not the case, and the fishing was done from the vessel's boat, a small extra motor had unfortunately to be resorted to to keep up the circulation. The motor itself was now in Deutz under test, and the results so far obtained with it were exceedingly favourable, the consumption of oil being very small. The governors gave good results. The vessel itself had been built in Kiel, and was so far advanced that the motor could shortly be put on board. There was still some little difficulty in connection with the driving of the net-winch. The trials with this had not yet been carried out, but it was hoped that all would be well with it. After the vessel had proved satisfactory in actual work he would communicate the results in order to supplement the material which had been given to the meeting by Professor Romberg.

Herr W. W. von Essen said that he had had the opportunity some years ago, at the Motor Boat Exhibition in Kiel, of pointing out the importance of the motor to the fishing industry. What he had then said still held good, as did also the importance of the fisheries to the navy. He disagreed with the author, however, in several particulars. That the Brons motor was reliable in working and economic under test, as stated, was no doubt true, but in practice the case was different; moreover, the technical expert was not the deciding authority on the question to the extent assumed throughout the paper. The author gave the front place to the work of the engineer; the speaker thought, however, that the matter lay more in the domain of fishing work and seamanship, and in this he had had considerable experience. But from a technical point of view also he did not quite agree with the author, as he considered that the Brons motor was not such a model of simplicity as was suggested by him; for instance, the compressor was said to be tight. Whether it really was so the speaker did not know. In connection with the hot-pot motor, which was also in use on fishing vessels, the use of the lamp and the warming-up process were found fault with, and attention was directed to the great danger to the vessel with which an open flame was fraught. He was not so much afraid of this; an ideal motor was not yet in existence, and never would be, and in the meantime he looked on the 4-cycle hot-pot motor as the best. The question whether this or that motor was worth consideration lay, not with the engineer, but with the fisherman himself, and organisations such as the German Sea Fisheries Association must try and get the conservative fisherman to take interest in the proposals made. He had still a word to say in reference to the prize which had been offered. He knew that the engineering firms had a great horror of such things. The best way to introduce the motor was to get the shipyards, the fishermen, and the motor builders to work together. The auxiliary motors also presented great difficulties.

Herr Meissner thanked Professor Romberg for the appreciation accorded by him to the oil motor for fishery work. He would like to raise the question of the reversing propeller. The question was a fair one, whether, in the interest of the development of the problem, it would not be better to dispense with the direct reversing of the motor. The reversing screw was the simplest solution. The fishermen must, above all others, have a motor that was as simple as possible, and a "sailing" screw was a necessity. A highly complicated motor, which in 99 cases out of a hundred did its duty but failed in the hundredth important one, was certainly not one whose introduction was to be desired. Moreover, the fishermen could not employ an extra hand to look after the complicated motor.

Direktor Saiuberlich observed that the author had pointed out that only a few German fishing vessels were fitted with motors. Now, when the motor—which by the way represented a value of £3500—and the net winch broke down, the net also was lost. The men who worked the motors had very little training, and it was not practicable to give them a technical expert; the marine motor was still in need of the marine engineer. The motor vessel would thus develop most rapidly if attention were bestowed on the training of engine-room hands; trial of the training ship must be made in this direction. Messrs. Frerichs had equipped with motors five sailing luggers that were now in service, and they had seven other luggers of the same type under construction. The reversing was here effected by means of adjustable-bladed screws, which were to be preferred to reversing gear. These vessels had yielded good results, and had weathered some heavy storms, in the course of which the motors had given every satisfaction, the engineer in one case reporting that he preferred the motor to the steam engine. The speaker was accordingly convinced that the Diesel motor was assured of a good future among the fishing vessels.

Professor Romberg, in reply, thanked Geheimrat Flamm for supplementing his statements. With regard to the observations of Herr von Essen, he wished to call attention to some inaccuracies. He had only endeavoured to give an unbiassed exposition of the really good qualities of the motor. Herr von Essen had said that the Brons motor was not a very simple engine. His own answer

was that it was as simple as it was possible to make a motor. He had, in his paper, represented the hot-pot motor to be simpler than the Brons motor. The compressor was faulty, since it was apt to leak. He was also acquainted with Brons motors and Diesel motors which had given no occasion for any complaints of consequence. He was aware that the principle of the hot-pot motor came from England. This motor was dangerous on account of the heating. Of this there could be no question. Every open fire or association with petroleum was a danger, but such dangers had to be reckoned with; bright lights were associated with deep shadows.

H.R.H. the Grand Duke of Oldenburg then thanked Professor Romberg again in the name of the meeting for his paper. They were the more grateful to him that he had shown them great advances made in this domain.

The third paper was entitled "Studies and Experimental Work for the Design of my Large Oil Motor," by Professor H. Junkers. Pointing out that a satisfactory large engine could not be produced by simply increasing the dimensions of a small one, Professor Junkers reviewed the considerations which had led him to the adoption of his system in its various parts, and proceeded to the description of the two-cycle process with high compression which Herr von Ochelhäuser and he had applied in an experimental motor built in the Gas Engine Experimental Institution in Dessau, and in which the fuel consumption was reduced to 60 per cent. of that required by the Otto motor, and the mean pressure at the same time increased to about 12 atmospheres. The main problems to be solved were, he said, those of the transmission of heat, and of the introduction of the charge in as cleanly a manner and at as low a temperature as possible. Experiments showed that the heat transmission depended principally on gas pressure and eddy action, and its extreme intensity during and just after the period of combustion required very special attention. An important point was to design the combustion chamber as far as possible with plain unpierced walls. Protracted studies and experiments had finally led to the construction of an experimental double-piston two-cycle horizontal gas engine, which embodied the principles evolved. Drawings of this engine were thrown upon the screen. The results being satisfactory, the next step was to adapt the system to the conditions of ship work. A further experimental engine, built with this view, was arranged in tandem fashion, two horizontal cylinders working each with two pistons. An outline sketch stripped of detail showed the positions of pistons at different stages of the process. Sketches of a 1000 horse-power experimental engine of 17¾in. diameter of cylinder were then shown and explained. The experiments with this engine were, it was stated, not yet completed, but it worked smoothly and satisfactorily. Particulars and plans were given of the 1600 shaft horse-power engine, on the Junkers system, under construction by the Aktien Gesellschaft Weser in Bremen for the Hamburg-Amerika Line. Except that the engine was a vertical one, the arrangement was similar in principle to the experimental ones. Provision was made for an eventual increase of 25 per cent. over the power to be normally developed. With six units a power of about 45,000 could be obtained. The cylinders were 35in. in diameter, with a 2in. by 28⅜in. stroke. The revolutions were 150 per minute with mean pressure by the diagram of 165 lb. per square inch, and a proportion of .65 between the shaft and the indicated horse-powers. The proportion borne by length of stroke to diameter of cylinder was 1.35:1. A further design for a set of horizontal engines for a large armour-clad was also given. The wear due to friction in the ordinary horizontal engine was stated to be very much reduced in the Junkers design, and a number of advantages possessed by this arrangement were enumerated. Comparisons between the Junkers engine and Diesel engines on the two-cycle and four-cycle systems showed in favour of the former.

The discussion on the paper was opened by Oberingenieur Schwarz, who said this was the first time that the question of large oil engines had been gone into in detail by the Institution. Professor Junkers had taken a considerable part in the development of these, and the detailed manner in which he had conducted his experimental work set an example that was worthy to be followed. He would like to make some additions which would increase the possibiltiy of the introduction of an oil motor for large work. The production of oil motors of the dimensions required, for example, for large war vessels was only a question of time. A large expenditure of work and capital would no doubt be necessary, but confidence was beginning to be placed in them. Turning to the Junkers design, he said it certainly had advantages, such as the simplicity of the combustion chamber and the avoidance of stuffing-boxes. The designer had also pointed out that these advantages were associated with disadvantages. The dimensions of the double piston engine had become rather considerable, and he considered it doubtful whether marine engineers, and especially the naval engineers, who were concerned with horizontal engines, would accept them. In the case of the horizontal engines, great care would have to be taken that the pistons did not corrode, and this danger was present in a high degree in ship work. Again, the connecting-rod arrangement was very complicated—much more so than in the large marine engine of the existing type. It was very doubtful whether such an arrangement of rods and crank shaft bearings would be accepted. The mechanism required extreme accuracy in the adjustment of the bearings, otherwise knocking and vibration would ensue; the danger of heating of bearings, however, was still greater. Whether, again, the avoidance of stuffing-boxes was such an important advantage might be doubted. In well-built engines damage to the stuffing-boxes seldom occurred. That they seldom leaked was borne witness to by innumerable engines on service. It was not clear why foreign firms had such an objection to them. The reduction in the number of the valves also was not so very great; only the scavenging valves being dispensed with.

Herr Holthusen said the marine engineer was, above all things, interested in the question whether the oil motor could hold its own with the steam engine. That was the main question. One point of special importance had not yet been mentioned, and that was reversibility. That was the quality which would, above all things, be demanded by captains. From this point of view the advantage would lie with the design which possessed this in an absolutely certain degree, combined with a like efficiency in other respects. Most of the oil engines were controlled by compressed air; a considerable cooling of the cylinder walls thereby took place. The combustion temperature of the oil mixture was 1200 deg. Cent. to 1600 deg. Cent., while that of the air introduced was the same as that of the atmosphere, and he was inclined to believe that this difference of temperature was a danger to the cylinders; all such dangers should be avoided. The speaker was acquainted with a design in which all these objections were obviated; this was the Hesselmann engine, and he might mention that a tug fitted with this motor was already at work in the Baltic and had fulfilled all expectations.

Direktor Toussaint observed that in the case of large diameters of piston, cooling had to be resorted to, in spite of the unpleasant complication which the engine thus experienced; in the 2-cycle marine Diesel motor piston cooling had often had to be provided as a subsequent addition. Now, in the Junkers motor, the scavenging ports were claimed as an advantage; in the 4-cycle motor, however, these could be dispensed with. Also the short stroke did not possess the importance attributed to it by Professor Junkers, for the advantage of the Junkers engine was due to its very long connecting-rods, and engines of such a height as his were useless for ships. It was, likewise, a great shortcoming of the Junkers engine that the surfaces and the clearance spaces were greater than in the normal engine. The speaker could not yet accept the view of Professor Junkers that the four-cycle engine was better than the two-cycle one. The disadvantages of the Junkers motor were thus greater than its advantages.

Direktor Saiuberlich said the reversing of the Junkers motor was the simplest imaginable; the apparently complicated external construction amounted, in view of the mass-balancing of the counter-working pistons, to a new economic departure, which was beyond competition. The Junkers motor would also prove a cheap engine for small work.

Direktor Regenbogen remarked that stuffing-boxes did not occasion very many repairs; there were excellent forms to be had, so that nothing was to be feared on that score.

Dr. Rieppel said he would only add a few words with regard to the stuffing-boxes. These were sufficiently reliable in practice. In a run of 120 hours, with a working pressure of 15 atmospheres, at the works of Messrs. Blohm and Voss, they had not caused the least interruption. He was of opinion that an oil engine could be built that could develop the very highest powers. Herr Junkers had attacked the problem at the point where its difficulty was greatest. The marine engine must, in the first place, be reliable in working. If comparison were made only between the Junkers engine and the ordinary engine, the dangers due to heat stresses were common to both, and the difficulty of reduction of the heat was greater in the Junkers engine. When these difficulties were overcome in both, an engine which had only one crank and one connecting-rod would be considerably more reliable in working than one which had three cranks and three connecting-rods. It was, moreover, a characteristic of marine-engine building that economy to some extent played a secondary part. Now, Herr Junkers reached an economy that was higher, indeed, than that of the Diesel motor; but would not an engine with a triple rod arrangement and considerably more moving parts than usual require larger allowance for depreciation and more lubrication than the normal Diesel motor? The economy of the Junkers engine thus became illusory. On the one hand, again, stood the long years of experience gained in manufacturing on a large scale, and on the other Professor Junkers with only a few actually built engines to go upon, and he believed therefore that the chances were not equal. The field of work, however, was so large that both could exist side by side in it, and every competitor wished Professor Junkers complete success.

The fourth paper was on "Experiments on Flow," by Professor J. Josse. Experiments and researches conducted by Professor Josse and Dr. Ing Gensecke at the Technical College in Charlottenburg have lately yielded valuable results in connection with the phenomena of flow through pipes and nozzles, the application of which is calculated to promote simplicity, combined with increase of efficiency, in turbines, as well as in condensing and refrigerating installations. It had, Professor Josse said, been found that, contrary to the usual assumption, when a pipe or channel was dimensioned in the manner hitherto considered suitable for a given velocity of flow, a further increase of the latter was accompanied by a steady decrease of the flow losses, and that the most favourable velocity for a pipe with parallel walls lay at the velocity of about 1968ft. (600 m.) per second. For the turbine these discoveries were considered to point in the direction of reduction in the number of stages required, and consequently of shortening and simplifying the engine, while at the same time increasing the velocity of rotation. Meanwhile, the Föttinger transformer had been improved, and now had a guaranteed efficiency in large installations of from 88 to 91 per cent., and the combination of turbine and transformer could be produced with an efficiency 30 per cent. in excess of that of slowly running turbines that drove the propeller direct.

The jet or injector action could be further applied to the sucking up and compression of gases and vapours. In a condenser a number of the lower tubes—one or more—were, for this purpose, arranged as jet-tubes, and the water sent through them at a moderate velocity by the already present circulating pump. The air could be drawn from the condenser at its coldest part, just above the line of the condensed water. For other condensing plants the arrangement was somewhat varied, but a removal of air without the application of extra energy could in all cases be effected.

The experience obtained in connection with condenser plant had enabled the lecturer with his co-workers successfully to attack the problem of the exhaustion, by means of high velocity jet action, of vapour from a water tank under very low pressure, which thus promoted the giving off of vapour by the water and its withdrawal of heat from its surroundings. The Josse-Gensecke jet cold-producing apparatus, a description of which was also given, contained, he said, no moving parts that could be subject to wear and require attention. Its simplicity was extreme. It cooled to a temperature of 23.2 deg. Fah., and in experimental laboratory installations it had lately been found that, by the addition of a certain small quantity of air along with the jet, a still better effect could be produced, the temperature sinking to 1.4 deg. Fah.

THE GERMAN SUBMARINE U 8.

VERY little information indeed is obtainable in this country regarding what is being done in Germany in connection with submarine vessels. It is shrewdly suspected, however, that a great deal more is taking place than is publicly announced, and that more submarines are in existence than are set out in the official lists. Be this as it may, it would appear at any rate that the twelve boats of the U class have been giving good accounts of themselves. The U class, according to "Jane's Fighting Ships, 1911," is divided into three sections—(1) U 1 by itself; (2) U 2, U 3 and U 4, and (3) U 5 to U 12 inclusive. U 1 is reported to have a displacement of 180 tons, to be provided with a four-cylinder petrol engine which drives the boat at 12 knots on the surface, and to have a length of 128ft. and a beam of 9ft. The submerged speed is given as 9 knots. Of the remaining vessels of the class not so much is known. It is understood that they have a displacement of something under 190 tons and a length of 138ft., but beyond this nothing can be stated with any certainty, saving that U 2, U 3 and U 4 are slightly different from the remainder.

According to a recent issue of the *Naval and Military Record*, however, one of the boats, U 8, has been acquitting herself well. It appears that the Emperor recently conferred special distinctions on her commander and chief engineer on account of "the quite remarkable performances" of this unit. Details are not published "in the interest of the service," but according to our esteemed contemporary inquiries made in naval circles have elicited the conjecture that the U 8 distinguished itself by a long cruise in bad weather, and that during the voyage she carried out some admirable diving manœuvres.

Although, however, comparatively few particulars are forthcoming concerning these vessels, we have been fortunate in acquiring four photographic views of the U 8 taken while carrying out evolutions at the surface, and these are reproduced on page 569.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Notice is given that the annual general meeting of governors and members of the Society will be held in the club-room at the Royal Agricultural Hall, Islington, on Wednesday, December 6th, 1911, at 3 p.m., to consider the balance sheet and the reports of the Council and of the auditors, to elect a president and trustees, vice-presidents, and auditors to hold office until the next ensuing annual general meeting, and to take cognisance of the election of ordinary members of Council made by divisions pursuant to the by-laws.

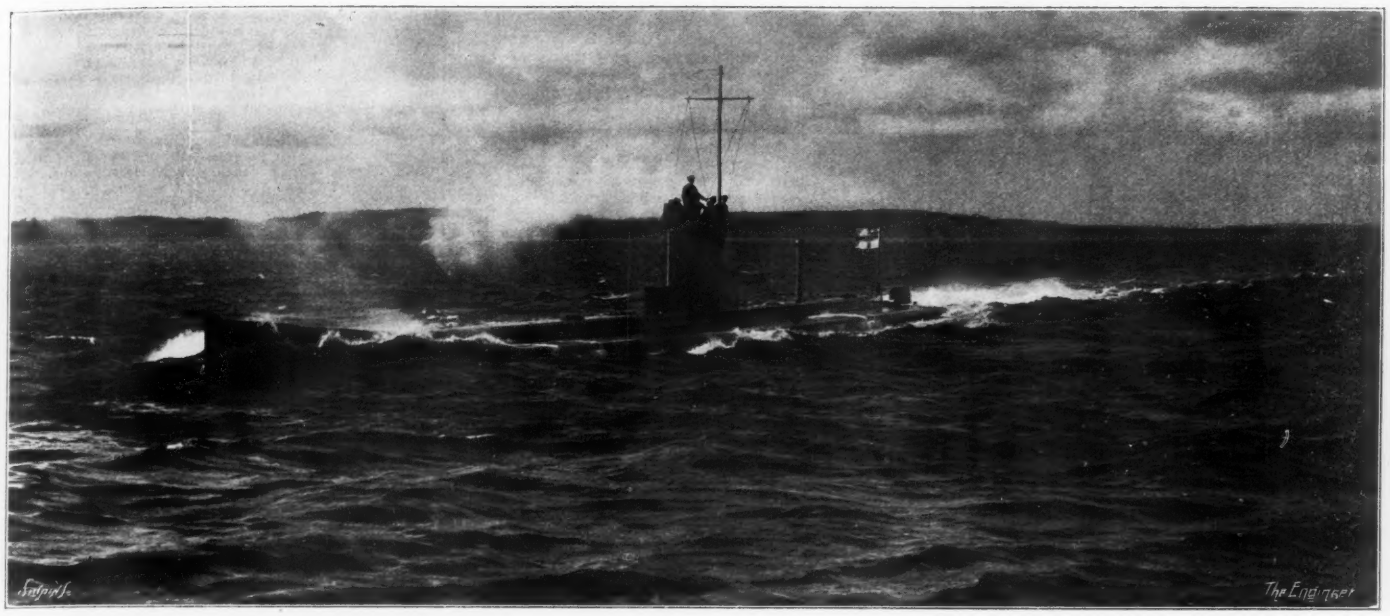
MOTOR FIRE ENGINES.—A large number of towns in the vicinity of London now possess motor fire engines. Among these may be mentioned Tottenham, Finchley, Harrow, Willesden, Bromley, Chislehurst, Dartford, Merton, Heston and Isleworth, &c. Two more must now be added to the list, viz., Penge and Mitcham, and in both cases the choice has fallen on the Merryweather petrol-driven motor fire engine with "Hatfield" reciprocating pump. The Penge engine will have a pumping capacity of 350 gallons per minute. In the case of Mitcham a 300-gallon engine has been selected. It is 27 years ago since the Mitcham Fire Brigade obtained its existing horse-drawn steam fire engine. It is of the Merryweather direct-acting type, and is still in service.

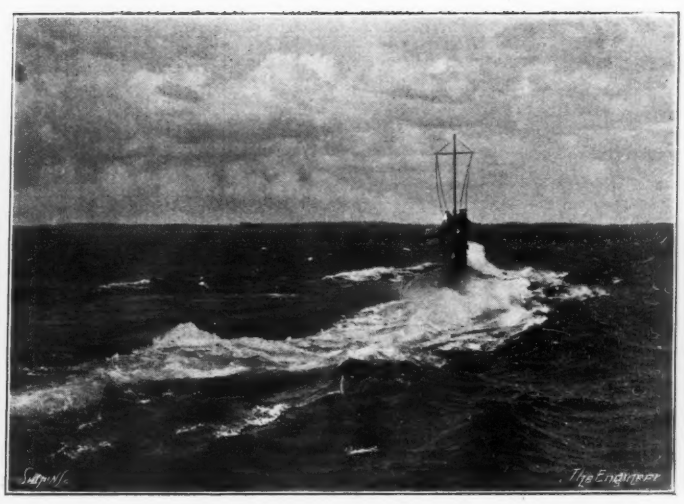
THE INSTITUTE OF CHEMISTRY.—The Council of the Institute of Chemistry has for some time past had in view the provision for the Institute of more suitable and permanent headquarters. This move is all the more necessary because the lease of the house which the Institute at present occupies—No. 30, Bloomsbury-square—terminates at Michaelmas, 1914, and there is no possibility of effecting a renewal of it. It is estimated that a ground area of about 4000 square feet will be necessary, and the Council is anxious to negotiate for a site which has come under its notice. This is regarded as being quite suitable, and it can be acquired on a 99 years' lease. Subscriptions towards the cost of the new building are now being solicited. The total amount required is about £15,000, and the amount already promised is about £8000. Some £7000 are still required, and contributions are now being asked for to make up this sum. Full particulars may be obtained from the registrar, at 30, Bloomsbury-square, W.C.

LARGE HYDRO-ELECTRIC INSTALLATION.—One of the largest contracts that has of recent years been placed in connection with machinery for hydro-electric power installations has been awarded by the Tata Hydro-electric Power Supply Company, Limited, through the medium of their consulting engineers, Messrs. Alfred Dickinson and Co., to the following tenderers:—Escher, Wyss and Co., for the hydraulic machinery, turbines, and pipe lines; Siemens Brothers' Dynamo Works, Limited, for the generators; the General Electric Company (of New York), Schenectady, for the transformers; and the Felten Guilleaume Cable Works, for the transmission line. The equipment will comprise four 9600-kilowatt generators, direct coupled to high-pressure tangential water wheels of the impulse type. The turbines will be designed for a head of 1740ft., and have a speed of 300 revolutions per minute, and regulation will be effected by automatic oil pressure governors. Instead of making use of pressure regulators, the turbines will be fitted with nozzles of the deflecting type, made in accordance with Escher, Wyss and Co.'s patent. The pipe line is one of the most important of its kind, both with regard to length and diameter as well as to difficulties entailed in its construction. Over 6000 tons of steel pipes are required, not taking into account the weight of the anchorages and auxiliary apparatus. The capacity of the plant at the Khopole power station will be about 38,000 kilowatts, but can be increased to 76,000 kilowatts at any time. For the excitation two separate units are installed, each of 600 kilowatts output, and driven by water turbines of the same type as the main turbines.

THE GERMAN SUBMARINE U8

(For description see page 568)





THE ADHERENCE OF FLAT SURFACES.

A RECENT communication to the Royal Society describes some investigations made by Mr. H. M. Budgett into the phenomenon exhibited by the adhesion together of two accurately plane, polished surfaces of steel. It has long been known that two such surfaces will adhere with much greater force than can be accounted for simply by the pressure of the atmosphere. In 1875 Professor Tyndall determined the force necessary to pull two Whitworth surface plates apart, and as he found that this force was still considerable when the experiment was conducted in a vacuum he came to the conclusion that molecular attraction was, in part at least, responsible for the adhesion. This view has since become generally accepted. In the light of Mr. Budgett's recent work, however, Tyndall's theory must go, and we must now attribute the phenomenon to the presence of a very minute film of liquid between the surfaces.

The fact that some steel gauges did not always cling together with the same force first attracted Mr. Budgett's attention to the subject. Then it was discovered that two blocks left wrung together for a long time required the use of a vice and hammer to separate them. When taken apart it was seen that the faces had rusted together, indicating that initially moisture had been present between them. Such a film would, of course, be readily formed if the blocks before being wrung together had been held in warm hands. Hence Mr. Budgett was led to try the effect of wringing two blocks together from which all trace of moisture and grease had been removed by cleaning the faces with alcohol. It was found that adhesion vanished, and that the blocks fell apart under their own weight.

A number of hardened steel blocks, each weighing 1½ oz., and having faces of 0.7 square inch in area, were prepared and polished flat to within a millionth of an inch accuracy. With these the adhesive properties of various liquids were examined. The faces of two blocks were first carefully cleaned with alcohol and then smeared with a very fine film of the liquid under examination. The blocks were then wrung together by a combined sliding and twisting motion. The force required to separate them was measured on a spring balance. With any given liquid there was a considerable variation in the pull required to separate the blocks. This was due to the difficulty of gauging the thickness and uniformity of the applied film and an element of uncertainty in wringing the blocks together. But, taking the average of many trials with each liquid, Mr. Budgett got the following results for the force necessary to separate the blocks:—Condensed water vapour, 35 lb.; turpentine, 29 lb.; paraffin, 27 lb.; oil of almonds, 24 lb.; lubricating oil, 22 lb.; olive oil, 20 lb.; sperm oil, 18 lb.; Rangoon oil, 17 lb. Volatile liquids, such as alcohol, benzine, and petrol, gave no adhesion. Viscous liquids, such as glycerine, treacle, and glucose, gave very little adhesion. By rubbing the blocks on the hands after washing with soap, values as high as 90 lb. were obtained for the adhesion.

To determine how much of the adhesion was due to atmospheric pressure, the blocks were separated in a vacuum. The average of twelve readings in air was compared with the average of twelve readings in a vacuum. The vacuum readings were, of course, lower than the air readings, but the difference is much less than most would expect. As the area of the faces of the blocks is 0.7 square inch, one would expect the atmospheric pressure to be responsible for about 10.25 lb. of the adhesion. But it was found that the difference between the air and vacuum readings never rose above 3.9 lb. (for Rangoon oil), and was as low as 1.1 lb. (for paraffin). It is clear then that air pressure was having access to a large part of the surfaces supposed to be in contact. If it be assumed that the film is continuous over the area of the faces, then F, the force necessary to pull the blocks apart, is expressible as $F = 2AT/d$, where A is the area of the faces, d their distance apart, and T the surface tension of the liquid. F A and T being known d can thus be calculated. Taking the constants for paraffin, it was found that the faces were theoretically 0.000005in. apart.

Microscopic examination of the smeared faces, however, revealed the fact that the film was not continuous, but really composed of small drops, which in the process of bringing the blocks together were drawn out into fine lines. The total length of these lines was measured, and assuming that the separation of the blocks took place by the rupturing of the fluid, Mr. Budgett calculated what proportion of the rupturing force was due to surface tension. In the case of paraffin he found that not more than 1 lb. could be attributed to this cause. Hence, of the total force of 27 lb. required to pull the plates apart when paraffin is the medium composing the film, 1.1 lb. may be attributed to the pressure of the atmosphere and 1 lb. to surface tension. The remaining 25 lb. or so are due to the actual tensile strength of the liquid. By microscopical examination Mr. Budgett came to the conclusion that not more than one-tenth of the surfaces was covered by the liquid. Hence the tensile strength of paraffin is 24.9 ÷ 0.07, or 355 lb. per square inch. Similarly, for water the tensile strength is found to be 443 lb., and for turpentine 371 lb. per square inch. These values are very much higher than those previously thought to be correct. In conclusion, we may state that Mr. Budgett has found that soft metals will not stand the stress put upon their surface by the film of fluid. Pieces of the polished surface may actually be dragged out in the effort to rupture the film. This effect is very noticeable in the case of glass. It is essential therefore that optical proof planes should be perfectly free from grease before use, as otherwise they will be ruined. Opticians do take this precaution, but it is probably more as a matter of routine than from any known reason why it should be necessary.

RAILWAY BILLS FOR THE NEXT SESSION.

BEYOND the new works in the London area mentioned in our last issue, and the fusion of the Tilbury with the Midland, there are no ambitious schemes coming before Parliament next session. The Great Central proposals are probably the most costly of these, as they contemplate extensive widenings at and near Mexborough and Doncaster—including a diversion of the river Don—and between Barnetby and Brocklesby. These are, doubtless, in anticipation of the opening of the Immingham Docks. The same company proposes to open out Darnall tunnel and widen the line, also to make agreements and execute works with the Great Northern, North-Eastern and Hull and Barnsley Railways. The Great Northern asks for sanction to extend its Waltham branch—a mineral line—so that it will join the main line south of Grantham, and the North-Eastern for connecting lines near Thorne. New railways in Swansea Vale are proposed by both the Great Western and Midland companies. The Great Western intends to double the remainder of the Kingswear branch, and widen the line at Solihull, near Birmingham. The Windsor and Ascot Railway is to be abandoned, doubtless in view of the agreement with the South-Western. The Ponsandane viaduct, outside Penzance, is to be filled in. An interesting proposition from the Great Western is to lay additional lines over six public road level crossings. In view of the jealous eye kept by the Board of Trade on the interference by railway traffic with the vehicular and foot traffic over level crossings on the one hand, and the great expense railway companies are put to in order to replace level crossings by bridges on the other, the result of these applications will be watched with interest. The Great Eastern proposes to spend money in order to expedite its seaside traffic. The Clacton and Felixstowe branches are to be converted from single to double track, and the portion from North Walsham to the junction of the Cromer and Sheringham lines is to be similarly treated. In order to avoid the necessary slackening of speed over two swing bridges where the line crosses the river Waveney, the line is to be deviated and two new swing bridges built, over which a higher rate of speed can be maintained. A new fish market is to be built at Lowestoft, which will necessitate the building of sea walls, the extension of the breakwater and reclamation of land. It is interesting to note that the North-Western seeks for sanction to supply electrical power to persons, firms, &c., alongside the lines that are to be electrified, and to enrol special constables.

ON THE MAXIMUM DIMENSIONS OF SHIPS.*

By Sir WILLIAM H. WHITE, K.C.B., F.R.S., D.Sc., LL.D., D.Eng., Honorary Member.

IT has been thought desirable during the present meetings to initiate a discussion on probable growth in dimensions of ships, and I have been requested to introduce the subject. Having given close attention thereto for many years, I have acceded to this request, and have prepared the following notes, which may serve as a basis for discussion, although they do not profess to cover the whole ground which may be discussed. The subject is undoubtedly important; it has an interest for naval architects, shipowners, dock and harbour authorities, travellers, and all classes of engineers. What seem to be chiefly needed are reasoned replies to certain questions: (1) Is it probable that the dimensions of ships will continue to grow at the rapid rate which has prevailed in recent years? (2) Will an upper limit to the sizes of ships be reached? (3) What considerations, if any, are likely to determine such a limit for either merchant ships or warships?

Facts and figures relating to the wonderful growth in dimensions of ships are necessarily familiar to members of this Society. Since wood ceased to be the chief material for shipbuilding and steam began to supersede sail power as the means of propulsion—say about sixty years ago—there has been a complete revolution in the design and construction of ships and an increase in size and speed which was undreamt of by our predecessors. Without attempting any detailed recapitulation of well-known facts, attention may be drawn to the circumstance that since the present century began the rate of growth in dimensions has been much accelerated. This will be seen from the two tables appended. In the first is summarised progress made in the sizes and speeds of Transatlantic steamships during the latter half of the nineteenth century; it also enables progress during that period to be compared with corresponding progress during the last ten years. Table II. deals similarly with armoured warships. In view of the greatly accelerated rate of increase in dimensions which has occurred during the present century and is indicated by these tables, one may well ask, Whereunto will this thing grow?

In endeavouring to answer that question some persons resort to simple graphic methods. Dates of construction are used as abscissæ, and lengths (or tonnages) of ships employed as ordinates. On these data curves have been constructed, whose production, in a tentative fashion, is expected to furnish some indication of what will probably be the dimensions of the largest ships, say, twenty or thirty years hence. Personally, I have no great confidence in this method. It has no scientific basis; it rests upon an assumption that materials and methods of construction, as well as systems of propulsion, will remain practically unaltered during the period under consideration; and it presumes that the law of growth will hold continuously. It may be replied by those who favour the method that it has answered fairly well so far, and that therefore it may be further employed with advantage. In my judgment, it is necessary to take a broader and more scientific view of the problem if a reasonably approximate solution is to be found. The means ought not to be altogether lacking for reaching a fairly approximate solution, if the conditions of the past and the outlook for the future are carefully considered. The case is not one for treatment by simple "rule of thumb" or more or less arbitrary extension of curves such as have been described; it requires an application of scientific analysis to past experience, and when this has been done, the forecast based upon such analysis must necessarily be open to question, and may be falsified by subsequent events. In these circumstances caution is necessary and differences of opinion are justifiable.

Probably the most useful procedure will be to make a detailed statement of facts and principles which will, for the most part, command general assent, and in doing so it may not be out of place for me to state my own conclusions on points of controversy.

1. It will be agreed that the law of growth in dimensions has operated hitherto on all classes of ships and that its action has, on the whole, been beneficial. Members of this Society treat as axiomatic the statement that economy in propulsion and over-sea transport has been and always will be promoted by increased dimensions. The actual influence of such an increase has, in many cases, been masked or made less obvious by concurrent changes in other factors and features of ship construction, but it has been none the less felt. Stronger materials of construction have been made available, more efficient types of machinery and propellers have been devised, higher steam pressures have led to greater fuel economy, and higher rates of revolution have favoured relatively lighter propelling apparatus. But after each such improvement has been introduced and utilised, the law of growth in dimensions has inevitably reasserted its claims on naval architects, and been again brought into operation in order to secure still further advantage in respect of speed, carrying power, or other features of ship design. Successive vessels belonging to each and every class have been made larger than their predecessors.

Excellent illustrations of this general law may be found in the development of the smaller classes of war vessels during the last twenty years. In 1892, as Director of Naval Construction, I prepared the first design for so-called "torpedo-boat destroyers" of which so much has since been heard. For the services then contemplated the dimensions thought most suitable were:—Length, 180ft.; breadth, 18ft. to 19ft.; displacement about 250 tons. The speed on trial was fixed at 26 to 27 knots, and this was sufficient for the purpose the vessels were designed to serve, viz., the destruction of then existing torpedo boats, which were of smaller size and less speed. At that date locomotive boilers were in general use for torpedo vessels, although water-tube boilers were coming into prominence. Marine steam turbines were not known, and quick-running reciprocating engines were necessarily employed. Our knowledge of screw propellers driven at rapid rates of revolution was much less than at present. Oil fuel was not a practical proposition. Mild steel was the best material available. During the last nineteen years the destroyer type has been developed in size and speed, and although the name has been retained, the services for which later vessels have been designed have not been limited to or even principally concerned with torpedo boat destruction. In fact the latest vessels in size and armament have grown into practical identity with the seagoing torpedo gunboats (Sharpshooters) which I designed in 1887-8 for the Royal Navy as the smallest self-supporting ocean-going type. In speed the later vessels are much superior to torpedo gunboats of earlier date, and this has been made possible by the use of steam turbines, water-tube boilers, oil fuel, stronger steel and other improvements. There is even now a considerable diversity of opinion as to the value of exceptionally high speed in the type; but in all cases the law of increase in dimensions has prevailed, and vessels classed as destroyers—really sea-going torpedo gunboats—range in speed from 26 to 35 knots, the largest having displacements of about 1000 tons.

Submarines also furnish illustrations of the working of that law. Boats of the Holland type adopted at the beginning of the century by the United States Navy, and soon after adopted for the British Navy, were of small dimensions—63ft. in length and of 120 tons displacement when submerged, the surface speed being 10 knots. By successive steps British submarines have been increased in size and speed, the latest examples, according to published reports, being nearly 180ft. long, 800 to 850 tons displacement, and 15 to 16 knots speed. In the United States similar growth in size and speed has taken place. In France the largest submarines of 1901 were about 135ft. long, 200 tons, and 12 to 13 knots speed; vessels now building are 240ft. long, of 1000 tons displacement when submerged, and the estimated surface speed is 18 to 20 knots.

The same general law has been at work in the mercantile marine. For each class the average size of ship has been increased, and the fact is apparent in every statistical "Return" of the movements of shipping. In 1860 the average gross tonnage of ships (exceeding 100 tons) on the Register of British Shipping was 340 tons; in 1870, 580 tons; in 1880, 1250 tons; in 1890, 1570 tons; in 1902, 2200 tons. Since the Suez Canal was opened the average size of the vessels passing through it has grown steadily; the same may be said of the vessels passing through the Sault Ste. Marie Canal. Every "Return" of ships entering and leaving the great ports of the world tells the same tale of growth in dimensions and tonnage. Each annual statement of shipbuilding throughout the world furnishes an illustration of the working of this law. Many small ships continue to be built, but there is a universal upward tendency in size.

2. It must be noted, however, that—notwithstanding the remarkable developments of the last ten years—the number of ships of extremely large dimensions is relatively few. These great ships naturally attract most attention; they are admittedly essential to the performance of special services; but the carrying trade of the world is mainly done by vessels of moderate dimensions. The British mercantile marine in 1910 owned 11,495 steel ships of 100 tons (gross) and upwards. Of these only 328 ships individually exceeded 7000 tons (gross), 107 exceeded 10,000 tons, and 20 exceeded 15,000 tons. At the same date there were about 5000 steel ships on the British Register of from 2000 to 6999 tons gross individual tonnage; and over 6000 ships of from 100 to 1999 tons. This enormous preponderance in numbers of ships of moderate dimensions has resulted from the operation of purely commercial considerations, which have similarly influenced all mercantile marines. Whatever may be the future growth in size of the largest ships built for special services, the bulk of the maritime business of the world will always be done by ships of relatively moderate dimensions, and they will continue to be the largest contributors to the revenues of port and harbour authorities. This fact, as will be shown hereafter, may have an important influence upon the upper limit of dimensions of merchant ships.

3. Naval architects will agree that, provided the money is forthcoming for building still larger ships, their construction will be possible: and that considerably increased dimensions will present no serious difficulty even if the materials for shipbuilding already available were not improved upon. Before iron was substituted for wood as the principal material for shipbuilding there was a period—within the recollection of the writer and many of his professional brethren who are still actively at work—when an upper limit of size and engine power seemed to have been reached in wood-hulled ships. Since that date metallurgists have made great advances, and progress is still being made; and on this side there is no bar to immediate and considerable increase in the dimensions of ships. The margin of possibility, indeed, appears to go far beyond any probable demand.

4. Existing physical conditions in the seaports, harbours, and docks of the world necessarily impose limits on the draught of water of ships. Much has been done at great cost to improve accommodation and to provide increased depths of water; but it is well recognised that the increase in dimensions of ships above described has been chiefly in lengths, breadths, and moulded depths; the increase in draughts of water when fully laden has been relatively small. This is made clear by the figures in Table I. Since 1899 the lengths and depths of Transatlantic steamships have been increased about 30 per cent., breadths have been increased nearly 40 per cent., but deep load draughts by only 10 per cent. This disproportionate increase in draught of water has imposed difficulties and disadvantages on the work of ship design which need not be dwelt upon in this gathering. Shipowners find themselves debarred from loading many existing vessels to the full draughts to which they might be safely laden, were there sufficient depths of water at terminal ports and were cargoes available. The earning powers of ships are thus lessened, and in these circumstances it is natural that a demand should have arisen and should still continue for greater depths of water and better accommodation for ships of the largest size.

While shipowners and shipbuilders urge upon authorities and proprietors of harbours and docks the necessity for prompt and liberal action, the latter may well be pardoned if they do not immediately respond to the demand, but require evidence that the large expenditure which would be needed to carry out these great engineering works will be followed by a corresponding and adequate increase of revenue. The difference in point of view is natural and inevitable. It is idle for those who are interested in ship development to ignore or treat as unreasonable this attitude of dock and harbour authorities who are responsible for a return to investors on the enormous capital sums administered by them. Of course, there are some great works which may be and are properly treated as national rather than private or local enterprises. The Ambrose Channel at New York—the navigation of the St. Lawrence and the Kiel Canal furnish examples; but such enterprises are exceptional in character and are avowedly undertaken for the benefit of the community as a whole, or for strategical reasons which lie outside the present discussion.

5. Up to the present time the response made to the appeal from shipowners for increased accommodation for larger ships by authorities of the great seaports of the world has been neither niggardly nor unsatisfactory. At the present moment extensive and costly works are in progress which will provide accommodation for the largest ships now building, and leave some margin for further developments. The Ambrose Channel to New York and the new docks provided at that port for the great Transatlantic liners furnish illustrations of the foregoing statement. At Liverpool and Southampton corresponding works are in course of performance

*Read at the eighteenth general meeting of the American Society of Naval Architects and Marine Engineers, held in New York, November 16th and 17th, 1911.

while still larger schemes are contemplated. It is not necessary to amplify this list, because it is a matter of common knowledge that all over the maritime world the same policy is being followed. Immense sums are being expended on improvements and extensions of docks and harbours, as well as on the approaches thereto, both by Governments and by proprietary bodies. One of the latest and largest schemes of this nature is that for the river Thames. From reports issued by the new Port of London Authority it appears that the estimated outlay for making the dock and channel accommodation of the Port of London suitable for the existing trade and for providing a proper margin to meet future developments will be about 14½ millions sterling (over 72 million dollars).

6. The marvellous growth of the world's commerce in modern times has enabled these great engineering works to be undertaken hitherto under conditions which have in most cases either yielded fair returns to investors in dock and harbour securities, or which have been considered by Governments beneficial to the whole nation and worthy of adoption irrespective of the return upon capital expenditure. In many cases this question of dock accommodation has been treated by great corporations—such as railway companies—as part of their schemes of operations rather than as independent undertakings. Modest returns have been accepted on large sums expended upon docks, because the existence of that accommodation has led to such an increase of earnings on the system considered as a whole, as justified the expenditure on docks. The growth of traffic in most of the great seaports has also enabled earlier docks to be fully utilised by vessels of smaller dimensions than those for which the latest docks have been constructed. But while this has hitherto happened it seems not improbable that a point may be reached beyond which dock and harbour authorities will not care to go in expenditure in order to meet further increase in dimensions and draughts in a relatively small number of the largest ships; and it is well understood that this consideration particularly applies to increase in draught of water, since the cost of dredging grows rapidly with increase of depth.

It is not my purpose to attempt any prediction of what the limit of depth of water will be in future. For the moment 40ft. of water at low tide seems to be the maximum contemplated; and most ports are content with less, especially when there is a good rise of tide. Keen rivalry between great seaports has hitherto greatly influenced both policy and performance on the part of authorities, and has given shipowners and shipbuilders practically what they have demanded. In the end, however, commercial considerations must prevail, and dividends must be earned by docks and harbours as well as by ships. In dealing with this matter, the more necessary because of the modern tendency to increased height and bulk of superstructures in which much of the passenger accommodation is situated. The effect of wind on the broadside in such cases is considerable, and on that account, as well as the great effect which tidal currents may have on ships of enormous length relatively wide entrances are needed in order to facilitate docking. As to draught of water, the figures given for merchant ships must be supplemented by about 2ft. to ensure sufficient depth of water under the keels for safe passage over the ground at low speeds. For warships the deep load draughts in vessels of recent construction are in many instances from 4ft. to 5ft. greater than the so-called "normal" draughts given in Table II.; the displacement tonnages when fully laden require to be correspondingly increased, and when vessels have been damaged by accident or in action, so that their draught has been increased and their trim affected, serious difficulties must be experienced in docking them unless there is a good margin of depth over the sills as compared with the "normal" draughts shown in Table II.

9. It is a fact worth noting that ships of the maximum dimensions now built or building are not easily accommodated or moved in the largest docks and harbours. The vessels are wonderfully handy, as all who have seen the Lusitania and Mauretania approach or leave the docks at New York or the landing stage at Liverpool will agree; but they necessarily require large spaces for their manœuvres because they are so long and heavy, and in the busy waters of their terminal ports caution is required. It has been stated recently that the provision of suitable docks at New York for the latest Transatlantic liners will involve an encroachment on the fairway of the Hudson River which may prove disadvantageous to the general traffic of the port. Whether or not this statement is well founded, the general truth of the foregoing remark will be admitted. Ships of 900ft. to 1000ft. in length, weighing 40,000 to 50,000 tons when deep laden, are not easily dealt with, especially when moving on restricted spaces and in tide ways, wherein other vessels are under way, and they themselves must necessarily move at low speeds. In many ports also the great draughts of water of the ships impose considerable restrictions on the water area which they can utilise with safety to themselves. Even in the terminal ports of the Transatlantic steamers difficulties are necessarily experienced, and although they have been overcome so far, they must be accentuated by any further increase of size.

10. For cargo steamers and warships no such fixed conditions or terminal ports exist. The former class are built to seek cargoes everywhere, and to deliver them wherever desired. Consequently, experience has led to the adoption of relatively moderate dimensions and draught of water, in order that their possible field of operations may be extended widely.

TABLE I.—*Transatlantic Steamships.*

Line.	Name.	Date.	Length.	Breadth.	Depth.	Gross tonnage.	Load draught.	Load displacement.	Horse-power.	Sea speed.
			ft.	ft. in.	ft. in.		ft. in.	tons.		knots.
Cunard	Persia	1856	360	45 0	31 5	3,300	23 0	6,000	4,000	13
White Star	Germanic	1874	455	45 0	36 0	5,000	23 0	8,500	5,500	16
Cunard	Oregon	1883	500	54 0	40 6	6,900	23 0	10,500	13,000	18
White Star	Teutonic	1889	565	57 6	42 0	9,700	23 0	13,000	20,000	20
Cunard	Campania	1893	600	65 0	41 6	12,500	27 6	20,000	30,000	22
White Star	Oceanic	1899	685	68 5	49 0	17,274	30 6	26,400	26,000	20.75
North German Lloyd	Kaiser Wilhelm II.	1903	678	72 0	52 6	19,360	29 0	26,000	38,000	23.5
Cunard	Mauretania	1907	760	88 0	60 5	31,938	34 0	39,000	75,000	25.5
White Star	Cedric	1903	681	75 3	44 1	21,000	32 0	32,000	13,000	16.5
White Star	Adriatic	1906	709	75 6	52 6	24,540	34 0	36,000	16,000	17
White Star	Olympic	1911	850	92 0	64 3	45,000	34 0	50,000	46,000	21
Hamburg-American	Imperator	Building	880	96 0	64 0	about	34 0	to	not	22
Cunard	Aquitania	Building	885	95 6	—	50,000	34 0	55,000	stated	23

TABLE II.—*Armoured Warships.*

Navy.	Name.	Date of order.	Length.	Breadth.	Load draught.	Load displacement.	Horse-power.	Trial speed.
			ft.	ft.	ft. in.	tons.		knots.
British	Warrior	1859	380	58	26 0	9,000	5,500	14.4
British	Bulwark	1899	400	75	26 9	15,000	15,000	18
United States	Maine	1898	388	72½	25 6	13,500	16,000	18
German	Wittelsbach	1899	394	68½	25 0	11,900	15,000	18
French	Suffren	1899	410	70	27 6	12,700	16,500	18
British	Lion	1910	660	88½	28 0	26,400	70,000	28
United States	Wyoming	1909	554	93¼	28 6	26,000	28,000	20.5
German	Moltke	1908	610	96⅔	27 0	23,000	50,000	25.5
French	Jean Bart	1910	541	88½	29 6	23,100	29,000	20
Argentine	Rivadavia	1910	585	96	27 6	27,500	39,000	22.5

Maintenance of speed in rough seas and storms is obviously affected by the relative dimensions of ships and waves. Storm waves in the Atlantic Ocean and elsewhere attain certain maximum dimensions. The observations of Dr. Scoresby, Lieutenant Paris, and others have enabled us to accumulate a great body of information respecting the sizes and speeds of ocean waves, and more than thirty years ago I brought these facts together in the "Manual of Naval Architecture." Certain additions to our knowledge of wave phenomena have been made since that date, but the main facts remain substantially as I stated them in 1877 for the information and guidance of naval architects. Ocean waves have not grown in size because larger ships have been built, and obviously there must be an upper limit of size, beyond which, so far as maintenance of speed is concerned, further increase in the dimensions of ships will have little or no effect upon regularity of performance of service between terminal ports. I have previously recorded my opinion that this upper limit of size has been reached for the Transatlantic service in the Mauretania and her sister ship, and I will now briefly state certain facts on which that opinion is based.

The Mauretania has averaged for a whole year, on thirty consecutive passages—fifteen voyages—westward and eastward, in all weathers and under varying and uncontrollable conditions of service, a mean speed of 25·5 knots. The highest mean speed going west was 26·06 knots; coming east it was 25·89 knots; the lowest mean speed was 24·92 knots in both directions. This regularity of performance has been repeated during service in two following years, the average mean speed being 25·25 knots and 25·1 knots respectively. In the series of passages made between February and August this year, the total number of revolutions of the screws during each passage varied only two per cent. above or below the number of revolutions per passage deduced from an average for all the passages. These figures may be left to speak for themselves. A closer approach to regularity of performance on the Transatlantic service can hardly be realised, whatever may be the sizes of the ships employed.

Experience proves also that in the Cunarders the limit of speed at which they can be safely driven in heavy seas is not fixed by their size, engine power, or general structural strength, but by considerations of the serious damage which might be done to fittings and navigational appliances, as well as to the officers and crew employed in navigating the ships, and of the safety of passengers if the ships were driven at high speed against heavy seas. No prudent commanding officer is likely to incur unnecessary risks in these directions; and so there comes a time when the vessels are not driven at full speed against heavy seas, but are slowed down until the weather moderates. This will always remain true whatever the sizes of ships may be.

In regard to steadiness in a seaway, long experience has shown that ships of less size may be more free from heavy rolling in a seaway than much larger ships if the latter are endowed with greater stiffness, and, consequently, move more quickly when rolling. Speaking on the basis of numerous personal observations made on ocean voyages, I can testify that this is the fact both for merchant ships and for warships. In recent years increase in the proportion of breadth to draught of water has tended to shorten periods of oscillation. No doubt in modern passenger steamers the lofty superstructures tend to raise the centre of gravity, and so to diminish stiffness and lengthen periods of oscillation. The increased breadth of ships has also tended to lessen the "effective wave-slope," and so to diminish rolling. Apart from detailed calculation, no exact knowledge can be reached respecting the probable behaviour and period of oscillation for a new ship, but that fact in no way contradicts the general statement made above, that large dimensions are not necessary to secure moderate rolling and easy motion. In modern warships of the largest types, as I pointed out in the paper read last year to this Society, the periods of rolling oscillation are actually less than the corresponding periods for smaller ships which preceded them; and it is certain that, as a result, the larger ships must prove less steady gun platforms than their predecessors under the influence of ocean storm waves, such as are frequently encountered.

XII. In view of the foregoing statements it becomes apparent that larger dimensions are not essential to good behaviour at sea, and that increase in length and weight beyond the Mauretania is not necessary in order to secure maintenance of speed on long ocean passages. It would appear therefore that the main determining factor in regard to maximum dimensions for future mercantile vessels must be found on the commercial side and not on the technical. If ships cannot be made to pay dividends on the capital sums invested in them—after meeting working expenses and cost of upkeep, and making due allowance for insurance and depreciation—they are not likely to be built.

The first cost of Transatlantic passenger steamers has been increased enormously during the last forty years. In 1874 a 15-knot steamer cost £200,000; in 1889 a 20-knot steamer cost £375,000; in 1893 a 22-knot steamer cost about £550,000; in 1899 the Oceanic, of 20·75 knots, with relatively good cargo capacity, cost £700,000; four years later a 23-knot steamer of about the same dimensions as the Oceanic cost £800,000. For later ships authoritative figures have not been published, but certain statements indicate approximately the sums which have been spent upon them. The British Government granted to the Cunard Company a loan of £2,600,000 towards the construction of the Lusitania and Mauretania, and it is understood that the actual cost of the two vessels exceeded that amount. The outlay on the Olympic has been put at about one and one-half million pounds sterling by men who had exact knowledge of what she has cost. The Hamburg-American and Cunard steamships now building would, on this basis, represent an expenditure of about one and three-quarter million pounds sterling per ship. There can be no doubt that experienced men who guide the policy of these three steamship companies have reached the conclusion that even such huge expenditure as these figures indicate will, on the whole, prove advantageous to the owners and lead to increased revenue.

It is not my purpose to attempt even the roughest estimate of earnings or working expenses for the new vessels. On the other hand, it may be well to call attention to certain facts and opinions which are already public property, and which bear on the subject. In 1902 a committee appointed by the British Government to consider and report on the employment of mercantile cruisers, and the subsidies proper to be paid for the services of such ships, expressed the opinion that commercial companies would require to be paid annual subsidies for swift steamships in order to make good "the loss which would be sustained in peace time for running such vessels." For ships having a sea speed of 25 knots the committee considered that the annual subsidy ought to be 15 per cent. of the first cost; for 23-knot vessels, 8.6 per cent.; for 20 knot vessels, 2.6 per cent. The essential point in this recommendation was that extremely fast vessels could not be worked without loss, and that if they were to be made available for use as auxiliary cruisers in war, annual subsidies should be paid. National sentiment was strongly in favour of recovering ownership of the swiftest ocean steamships for Great Britain. Parliament approved that action; an agreement was made with the Cunard Company to build the Lusitania and Mauretania; an annual subsidy of £150,000 was arranged, and the loan above-mentioned was granted at 2½ per cent., to be repaid in twenty years. Only the owners of these two vessels can know whether or not they have earned dividends, and it is their concern alone. It is noteworthy, however, that no attempt has yet been made to surpass these vessels in speed, and that the five ships of greater size for which particulars are given in Table I. are intended to be slower than their predecessors. They may, in fact, be regarded as the latest developments of the "intermediate" type of Transatlantic steamships, rather than as additions to the series of "express" passenger steamers in which very little cargo is carried, of which the Cunarders are the latest examples.

The essential characteristics of the "intermediate" type of

therefore, the conflicting claims and interests of all who are concerned not only with shipping, but with docks, harbours, &c., must have due consideration. The advantages to be obtained by the whole community, and not the profit of a particular section, ought to and will determine what is done eventually.

7. The following brief summary of facts relating to the dimensions of locks and dock entrances recently constructed or now in process of construction may be of interest as indicating the outcome of inquiries set afoot by responsible authorities in regard to the provision of suitable accommodation for the largest ships likely to be built. On the Panama Canal the locks are 1000ft. long, 110ft. wide, with 40ft. of water over the sills. On the reconstructed Kiel Canal the locks are to be 1080ft. long, 147ft. wide, with 36ft. of water over the sills, but provision has been made in the structures for increasing this to 46ft. if required hereafter. The new Gladstone Dock at Liverpool is to be capable of receiving the Cunard steamship Aquitania when she is completed, and still larger vessels; it is really part of a great scheme of dock extension. This dry dock will be 1020ft. long, 120ft. broad, with 44ft. of water on the sills at high water, ordinary spring tides. On the Clyde a dock of nearly the same dimensions as the Gladstone Dock is now under construction, with 36ft. of water on the sills at high water; but the rise and fall of tide is less than at Liverpool. The Port of London Authority contemplates the construction of a dock 1000ft. long, 120ft. wide, with 40ft. of water over the sills. At the new naval base which the British Admiralty are constructing at Rosyth (Firth of Forth) the plans originally provided for a lock 850ft. long, 110ft. wide, with 36ft. of water at low tide, and for a dry dock of similar dimensions, except that it was to be 750ft. long. It is understood that some increase in length and breadth is probable.

Approach channels have been deepened considerably. A depth of 40ft. at low water is to be secured throughout the Ambrose Channel; at Southampton access is to be secured at all times for ships drawing 34ft. to 35ft. At Liverpool the minimum depth of water at low tide in the "cut" through the bar of the Mersey is maintained at 30ft. On the St. Lawrence works in hand are intended to give a minimum depth of 35ft. from Montreal to the sea—a marvellous change from the minimum of 10ft. to 12ft. formerly existing on that river during the greater part of the navigation season. On all sides there is and has been recognition of the need for ample depth of water.

8. When the foregoing particulars for locks, docks, and approach channels are considered in the light of dimensions of ships given in Tables I. and II. it will be seen that the margins provided in most of the recent engineering works are not very great in regard to length and breadth, although they are expected to prove sufficient for many years to come, because of the commercial considerations above mentioned. To the lengths of ships tabulated must be added about 30ft. to 35ft. in order to obtain the lengths "overall," and in regard to breadths it is obvious that good working clearances in breadth are desirable for ease and safety of handling these enormous vessels when passing through dock entrances. This is

Warships are designed to operate from special bases, but they must find great advantage from being able to enter and utilise other harbours or sheltered waters where the depth of water is moderate. It is desirable also that they should be capable of proceeding to any place where an enemy can be found, and thus enlarge to the utmost their field of operations. Moderate draught of water is therefore an important feature of warship design, and the tendency in recent years to a considerable increase in the deep load draughts of warships is, from this point of view, objectionable. As above stated, the "sinkage" of modern warships—from normal to deep load draught—is frequently 4ft. to 5ft.; and although this fact may be ignored in statistical returns it must seriously affect the practical working range of action of the vessels in war time. In respect of draught of water, the United States Navy formerly favoured shallowness—indeed, insisted upon it—although naval architects did not fail to point out the penalising influence of that restriction. It will be interesting to be told why this remarkable change of attitude has been made. It is notorious that some of the most recent capital ships added to war fleets cannot when fully laden find shelter in harbours which have been built primarily and at great cost to serve as naval bases, and they cannot be placed in many existing dry docks, in case of injury in action, because of their considerable load draughts. It will not be disputed that one essential factor in framing a shipbuilding programme for any war fleet should be the consideration of the harbour and docking accommodation which will be available, in case of war, for the reception and repair of the largest vessels. For warships as well as for merchant ships expenditure on ships and armaments must be considered concurrently with that on harbours and docks, and in every well-devised programme the two things must be dealt with concurrently. This is a truism, no doubt; but past events prove that it may none the less be neglected in the excitement of a race to produce the "biggest warships," each carrying the greatest number of the heaviest guns.

11. Enlarged dimensions, of course, enable certain advantages to be obtained outside the fundamental gains of economy in sea transport or increased speed. Amongst these advantages are:—(*a*) Maintenance of speed at sea in rough weather, and increased uniformity of service between terminal ports. (*b*) Greater steadiness and good behaviour in rough water and increased comfort for passengers, if naval architects are left free to utilise fully the greater size of ships. Not infrequently they do not enjoy such freedom, because the conditions laid down impose limitations on their choice of dimensions and proportions. (*c*) Better and more spacious accommodation for larger numbers of passengers. (*d*) The attraction which many passengers have toward the "biggest ships afloat."

A few remarks may be added respecting the first and second of these supplementary gains due to larger size in passenger steamships.

steamships are moderate speed in proportion to length and displacement, and the association of large passenger accommodation with a considerable cargo capacity. Moderate speed, of course, permits of relatively moderate engine power, lessens the coal bill and engine-room expenses, makes less demands for space for engines, boilers, and fuel, and leaves free for other uses a larger proportion of the internal capacity than in express steamers. All these differences obviously tend to increase net earnings in vessels of the intermediate type relatively to express steamers of equal size, but much higher speed; provided that passengers and cargo can be obtained. On the other hand, if cargoes are obtained which utilise the full dead weight capacity of a very large steamer of the intermediate type, it may happen that the period of detention in port may be considerably in excess of that required for the passenger service and for re-coaling. As a consequence there may be so considerable an increase in the time spent in port—during which the capital is unproductive—as will seriously diminish the net earnings. Every one agrees that for large and costly ships a quick "turn round" is of vital importance to commercial success and the shipment and discharge of large cargoes must interfere with that procedure.

It is not my purpose to attempt any detailed discussion of this branch of the subject, nor have I the experience which would enable me to do so. Speaking to naval architects, however, it may be permitted to make a brief statement which will illustrate the points last raised, and show the essential differences between the Mauretania and Olympic, the first costs of which probably approximate. Let it be assumed that the two ships start at the same deep load draught—34ft. Allowing for differences in speed and engine power the coal burnt for propulsion on a Transatlantic passage by the Olympic at 21 knots would be about 70 per cent. of that required for propulsion by the Mauretania at 25 knots. For other purposes the daily coal consumption of the Olympic would rather exceed that of the Mauretania because of her larger size and greater number of passengers. The duration of the passage would be about 20 per cent. longer for the Olympic, and on this basis the dead-weight cargo capacity of the Olympic at the load draught assumed for both ships would probably exceed that of the Mauretania (roughly) by 10,000 tons. This is obviously a potential source of larger earnings, provided cargoes can be secured and dealt with in port without objectionably long detention. It may be doubted whether this full cargo capacity would be frequently utilised, even coming eastward, and going westward there would be no prospect of its utilisation under the conditions of actual Transatlantic service. If not so utilised the vessel could, of course, be worked at lighter draught, or could carry coal from England for the voyage out and home, or be otherwise dealt with. On the other hand, the under-water form would always remain that which was selected as appropriate to the carriage of a large dead-weight; and if the provision made for cargo had been less it would have been possible to produce a vessel of smaller displacement and less cost having the same speed, with reduced working expenses and equal passenger accommodation. These remarks are made in no spirit of criticism. Those who were responsible for the construction of the Olympic are undoubtedly masters of all details of shipping and ship management, while I am only an outsider in mercantile affairs and necessarily regard the problem from the point of view of a naval architect. Even that point of view should not be ignored, however, and it will have an influence on the future developments of mercantile steamships.

13. For warships other considerations than those of first cost and cost of maintenance must determine the maximum dimensions which should be adopted. Their case is therefore distinct from that of merchant ships, and must be considered on its merits. Advocates of further increase in size and cost of warships take a different view, and argue that because a few mercantile steamships have reached dimensions far in excess of those attained by warships, therefore it is reasonable to follow a similar course in warship construction. This argument has already been dealt with indirectly in Section 10 of this paper. The comparatively few merchant steamers of very large dimensions now in existence have been built for special service between known terminal ports, whereat proper accommodation for them has been provided. Their employment consequently differs radically in character from that of warships which are intended to seek out and find an enemy wherever he may be. In order to secure success, therefore, each navy needs a considerable number of ships, and the draught of water of individual vessels ought to be moderate in order that their field of possible operation should be large.

Warships are also exposed to special risks, to which there is nothing corresponding in the services for which great mercantile steamers are constructed; and as a consequence it is essential to provide for considerable numbers as well as for individual power in the constitution of each fleet. It is admittedly a correct definition of the problems involved in the arrangement of an "establishment" for any navy, to say that it must rest on a definite plan of campaign, the fulfilment of which requires the construction of a certain number of ships of various types suitable for various services, and ranging from capital ships—forming units in squadrons and fleets—down to the smaller classes of armed vessels and the fleet auxiliaries. For each fleet of capital ships it is necessary to arrive at a decision as to the best distribution of the total sums to be expended on construction and subsequent maintenance, and in reaching such a decision regard must be had to the special risks incidental to modern naval war as well as to the necessities of naval operations, which must demand the capability of either concentrating or distributing the force as the varying conditions of a campaign may require. Problems such as these naturally, indeed necessarily, give rise to different solutions, and there is room for various opinions as to the best possible arrangements in proportion to total expenditure. My personal opinions on the subject were expressed in the paper on "Armaments of Battleships," which appears in the "Transactions" of this Society for last year. It may assist the present discussion if they are briefly summarised.

(*a*) Multiplication of the heavy-gun positions in capital ships, and of the number of such guns carried by individual ships, has necessarily involved increase of lengths and displacements.

(*b*) Concurrently with this alteration of armament there has been an increase in speed and fuel supply; this has involved further increase of size.

(*c*) Modern capital ships—with heavy-gun armaments and great weights of armour placed high above water—must be endowed with considerable initial stability in order to possess a reasonable range of stability under ordinary peace conditions. Hence they have been made very broad in relation to their draughts of water—even after allowance is made for the increase in draught, deep laden—as compared with their predecessors.

(*d*) Their moderate range of stability—when intact—gives to these ships a less margin of safety when injured in action by gun fire; and, in many instances, the distribution of the armour is of a character that adds to this risk, because it leaves without protection large areas of the sides which are reckoned as water-excluding in calculations of stability, although they can be rapidly riddled and destroyed by shell fire with high explosives. In later designs the areas which are armour protected have been considerably increased; but the addition to the weight of armour placed high above the water-line has necessarily been accompanied by a rise in the position of the centre of gravity of the ships. The breadths have been still further increased in proportion to the draughts, and even then the range of stability in the intact condition is very moderate.

(*e*) Modern warships, notwithstanding their greater size, are not, and cannot be, as steady gun platforms as their predecessors; because their great initial stability causes them to have relatively short periods of oscillation. As a consequence they are more likely to be set rolling by ordinary conditions at sea. Experience has shown them to be less steady in a seaway than ships of earlier date and smaller size. Some of these ships are so large in relation to the available dry docks that their bilge keels are either very shallow or non-existent at the midship portions of the length, and as a consequence the check upon rolling is greatly reduced.

(*f*) The development of under-water attacks proceeds rapidly. Torpedoes are now larger, have greater charges, are much faster, and can be used at much longer ranges. Submarine mines have been used with great effect in actual warfare, and will be used in future with greater effect. Submarines have been developed, and are now being made of dimensions, speed, and radius of action which probably enable them to act as auxiliaries to fleets over considerable areas of operation. Advocates of very large dimensions in warships admit that one successful under-water attack will probably put the largest warship out of action. It cannot be questioned that the increase in length and speed of recent ships will necessitate an increase in the intervals between successive ships in the line of battle, and the danger of successful under-water attack will be increased because both individual ships and the line of battle formed by a certain number of ships must be made longer.

(*g*) In view of the foregoing considerations it appears to be desirable to put a limit upon the size and cost of individual warships and the concentration of so many guns in a single ship, because a single successful blow may bring about a serious proportionate loss to a fleet by one ship being put out of action. Moreover, the withdrawal of a single ship from a fleet for temporary employment on detached service would involve a serious loss of power, which, with more numerous vessels, would be avoided.

(*h*) Special dangers must be incurred by the multiplication of heavy guns and of magazines placed below them. Some of these magazines are necessarily in the neighbourhood of boiler spaces or bunkers, where high temperatures are unavoidable. No doubt the dangers are lessened by fitting appliances for keeping magazines cool and by other devices; but although lessened they are not absolutely overcome, and the risk of explosion—as sad experience proves—remains. The loss of the Liberté, which is universally deplored, following upon a previous accident to the Jena, demonstrate the possibility of possible and sudden destruction in this fashion of the largest ships, and furnishes a fresh argument against "putting too many eggs in one basket."

My personal conviction, based upon long-continued study of the problem, is that the wiser course in warship building would be found in a return to more moderate dimensions and a reduced unit cost for capital ships. Experience has established the fact that, without having resort to the extreme dimensions which have recently found favour, it is possible to produce capital ships which shall be powerfully armed, well protected, steady gun platforms, capable of fighting their guns in all weathers when actions could take place, and able to maintain their speed in rough water. The value of high speed in capital ships has been much discussed, but it really opens up a separate field into which it would be undesirable to enter now. Suffice it to say that with equal speed a reduction in the number of heavy guns carried in a single ship such as I advocated last year would enable considerable reductions to be made in size and cost; and that for a given total expenditure on the first cost of a fleet or squadron a more formidable and flexible force could, in my judgment, be obtained, with greatly reduced risks from either gun fire, under-water attacks, or magazine explosions. It would probably be true that the more numerous fleet would cost more for manning and maintenance, but the price which would have to be paid in this direction would be well earned by advantages in other respects, and above all by a greater prospect of success in the day of battle.

In conclusion, let me express the hope that the discussion which this paper is intended to provoke may have as its main result the discovery and record of points on which there is substantial agreement; and that it will put on record a clear as well as a reasoned statement of points on which differences of opinion exist, as well as the reasons for such differences. No doubt in the end we shall have to "agree to differ" respecting some matters, but it will be of advantage to have minimised these differences and to know how far we agree.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE MECHANICAL PRODUCTION OF RUST.

Sir,—I have read your remarks on the above subject with a great deal of interest. The title seems somewhat misleading, as the effect must be confined to a predisposition of steel surfaces subjected to alternating stresses to oxidise easily. A mere chemist can see no exclusion of moisture in the experimental conditions, nor would he admit the absence of condensation by the metallic surface. He would also question the formation of anhydrous rust, and even that of rust absolutely free from carbon dioxide. That iron exists in many energy forms we all know, and that a vast number of alternating stresses should produce a higher energy form seems hence only natural. Increasing the surface by ordinary filing produces a powdered iron, which you cannot keep from oxidising without the most elaborate precautions. Going one step further, and reducing finely powdered oxide of iron with hydrogen, you get a metallic powder, which ignites in the air at ordinary temperature. Whether it will do so in an absolutely dry atmosphere is, however, both doubtful and improbable. Oxygen, dried over phosphorous pentoxide, does not attack sodium or potassium, which can be distilled in such an atmosphere, phosphorous does not burn, sulphur very slowly, &c. Tellurium, selenium, boron, arsenic, and antimony burn. But even then we know from the phase rule that phosphorous pentoxide cannot remove moisture absolutely. Dixon's experiments with a mixture of carbon monoxide and oxygen show a certain quantitative relationship between our various modes of drying. He found the velocity of the explosion in metres per second as follows:—

	Metres per second.
Gas mixture dried over P_2O_5	36
" " " H_2SO_4	119
" " saturated H_2O + 10 deg. Cent.	175
" " " " + 35 "	244
" " " " + 60 "	317

The mixtures were exploded electrically at a pressure of 200 mm. Hg. It is fully evident that the amount of moisture increases the reaction velocity rapidly; also that drying over H_2SO_4 is very inefficient. From the figures given the gas would have contained about 0.4 per cent. of H_2O by weight after that treatment, and something less than 0.1 per cent. in the other case, both very feasible figures. Dixon did, however, manage to dry his gas mixture sufficiently to prevent explosion by carefully "drying the eudiometer as well as the gas," an observation confirmed by Roszkowski. Mixtures of hydrogen and oxygen exploded, on the contrary, to the spark in spite of all drying. Everything does, however, point to the impossibility of excluding moisture altogether by means of drying agents, which is also a theoretically necessary thing, as continuity between a solid or a liquid and a gas is unthinkable unless the solid or liquid possess vapour pressure of some magnitude, however small it may be. We simply cannot exclude water at ordinary temperature. To assume its absence in an ordinary laboratory atmosphere is hence more or less of an absurdity. That moisture will condense on a metallic surface from an unsaturated atmosphere is patent to everybody who is in the habit of weighing platinum basins. When taken from a desiccator the pressure and temperature of which are balanced to the surroundings, a large basin will increase in weight in the partly dried atmosphere of the balance case very rapidly. Large glass vessels are put as just as great sinners; in fact, so much so that, when closed weighing bottles are used, it improves the accuracy as well as the speed of working to use no drying agent either in the desiccators or in the balance cases. You may call this phenomenon occlusion, or condensation, or anything; still, it is material enough to be affected by rubbing the articles weighed with a silk handkerchief. Now, if a steel bar suffers granulation—macroscopic, microscopic, or ultra-microscopic—under alternating stresses, which increases condensation, then we can see our way to explain the enhanced corrosion in the ordinary manner. If the modification of the metallic iron should be "allotropic," *e.g.*, another molecular aggregation, then there are plenty of parallels with other metals like antimony and tin, &c. The latter metal changes by internal stress into the grey modification on its own accord—it becomes granular and falls to powder in time without oxidising very much. You might probably produce the effect quickly by vibrating a piece of tin. According to some authors, these two modifications are electrically different, sufficiently so to allow mensuration. It would be interesting to see whether the parts of the steel bars which showed rapid corrosion are electrically different from the unaffected parts when opposed to them in a solution. I have observed that pure metallic zinc gets more corrosible by wire-drawing. As a matter of fact, that metal behaves in a most extraordinary way during the process of drawing. After "breaking down" between 100 and 150 deg. Cent. with the utmost difficulty, you suddenly find that you can go on drawing through die after die without heat treatment. The silver white wires soon lose their lustre, even in closed bottles, whereas the cast metal keeps bright for years under the same conditions. I have also observed that freshly made wires dissolve more easily in acids per surface unit than the cast metal from which they were drawn. These and other similar observations require a great deal of quantitative confirmation, and they are given merely as examples of what you may observe in every-day life. To imagine that a great number of alternating stresses will make steel more corrosible requires no higher flight of fancy than that heat and pressure should make phosphorus alter colour, ignition temperature, heat of combustion, physiological action, &c. That a heat treatment should also involve the loss of some 10,000 cal. per gramme molecule of the substance heated is truly marvellous. The alteration of the steel would at least mean absorption of energy—a more congenial proposition. To assume, in addition, that a conductor should react without exchange of ionisation charges does, however, seem both unnecessary and inexpedient in view of the evidence offered.

November 27th. John Rhodin.

[Mr. Rhodin's letter gives material for much thought, but we suggest to him that in making corrosion of this kind so simple and obvious he has proved too much. The conditions he assumes exist in a thousand places where there is nothing like the accelerated corrosion of these test pieces. Take, for example, the spring that holds the pendulum of a clock. It is generally supported in a gun-metal or brass bracket. It is under alternate stresses for years, in atmospheres of all degrees of moisture, and yet no pronounced rusting is shown. Again, it is common to hold bright steel bars in collet chucks in lathes for hours during machining, when they must be subject to varying stresses, due to the cut, but we never heard of the work rusting in the chuck. Scores of similar instances could be given, which all tend to show that the phenomenon is not universal, as it should be if Mr. Rhodin's views could be accepted without reservation. We agree with him that an electrolyte, possibly condensed from the hand of the operator, combined with the different electro-chemical activities of the specimens and the holders, is probably at the back of the trouble; but why is the action so energetic, why does oiling not prevent it, and why is it not found universally instead of exceptionally? We may hope to find out more about it if anyone who has observed unexplained cases of accelerated corrosion under parallel conditions will give us an account of his experiences.—Ed. The E.]

ENDURANCE OF METALS AND RUST.

Sir,—The statements made in your last impression concerning vibration as a cause of oxidation are startling and full of interest. In their present form they are, however, far too incomplete to permit the forming of any useful hypothesis. As they stand they involve several contradictions. In the first place they are apparently quite inconsistent with the well-known truths that railway metals in actual use will not rust, while those at the side of the line will. In the first case little more takes place than the formation of a quite superficial rusting—a mere discoloration indeed. It seems to me that the rail under the tread of wheels is under conditions very similar to those mentioned—conditions which in one case cause rusting, and in the other actually prevent it. Much the same thing may be said of railway carriage axles, which never rust if the carriages are in use.

As to what goes on, we can only assume that the molecules of iron behave much as they do when a bar is being magnetised and demagnetised. It is known that they turn on their axes. In other words, a bar of soft iron is little more stable as regards an electric current than is a bag of fine sand when shaken by hand. It is also well known that vibration under stress magnetises bars of steel and cast iron; for example, drills and files, to mention only two out of dozens. It seems to be possible that vibration under bending stress may lead to such molecular movements as to cause the segregation and occlusion of oxygen. It is very desirable to ascertain whether the test pieces became magnets.

A good many years ago a system of making rifle barrels was tried in London. A solid bar was bored out and then fitted with an "acorn" on the end of a rod and cold-drawn through a die. It was maintained that the strength of the tube was enormously increased by the cold-drawing—practically a new process then. This drawing gave results now and then which confirm the experience of Dr. Cormack as given in the third column of page 533. The die and the tube became very hot, and the stress was greatly augmented. I found at last that in all cases this was due to the presence of almost microscopic specks of some very hard substance between the die and the barrel. A scratch was made on the barrel just what would be produced by a needle. I never met with anyone who was able to give any explanation of what took place or what was the nature of the process by which a particle of dust increased the resistance and raised the temperature so high. When the surfaces were quite clean there was hardly any heating.

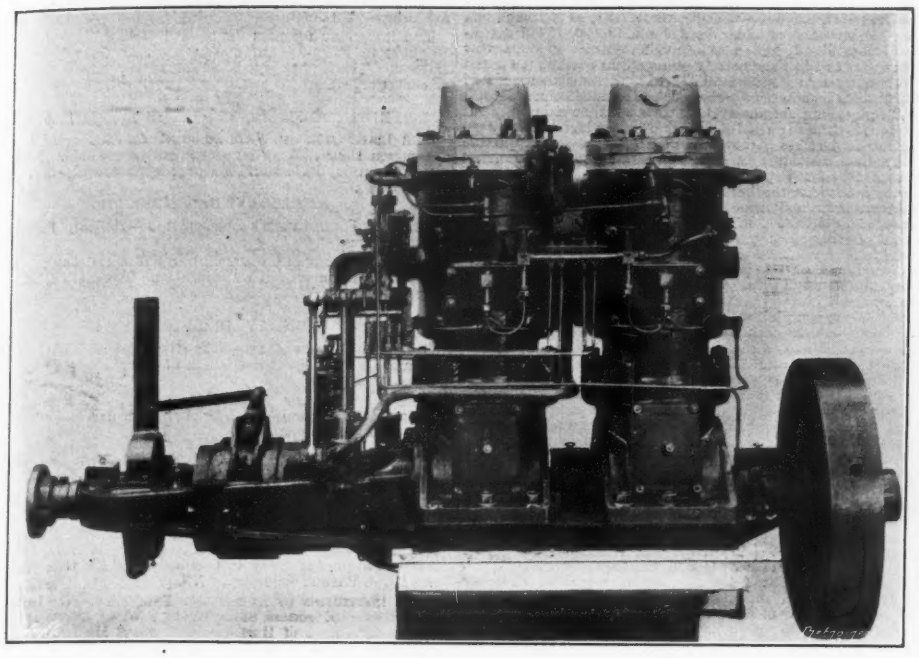
Many of your readers will no doubt look forward to the publication of more facts in your columns with as much interest as

November 27th. An Old Rivet.

London Electrical Engineers' Club.—On November 18th the newly formed club in connection with the corps of London Electrical Engineers held its first annual dinner at the Monico Restaurant, Piccadilly-circus. It was a great success. After the loyal toasts had been duly honoured, Col. L. C. Jackson, C.M.G., R.E., proposed the toast of "The London Electrical Engineers," and spoke of them as being the most serviceable unit in the Territorial Force, not requiring a week's drill to get into shape, but ready to be of use at a moment's notice. Lieut.-Col. H. M. Leaf, commanding, and Col. R. E. B. Crompton, C.B., the honorary colonel of the corps, replied in excellent speeches, after which Col. Crompton distributed the various prizes won during the year in work and in athletics by companies and individual members of the corps. The toast of "The Visitors," proposed by Capt. T. Rich, and responded to by Lieut.-Gen. Sir Alfred Keogh, K.C.B., and Prof. Dalby, brought to a conclusion what had been a most enjoyable evening.

TWO-CYCLE CRUDE OIL ENGINE

PLENTY AND SON, LIMITED, NEWBURY, ENGINEERS



A NEW CRUDE OIL ENGINE.

IN our article on the Yarmouth Show last year we laid great stress on the necessity for studying primarily, not first cost and consumption per horse-power, but rather the cost of the class of oil to be used in an internal combustion engine. That these remarks were not only justifiable, but that they have already been realised by at least one maker, is indicated by the description which we publish to-day of the new type of engine which has just been placed on the market by Messrs. Goedkoop, of Amsterdam, who have made a name for themselves hitherto as makers of a four-cycle engine using paraffin as fuel. The new engine not only works on the two-cycle principle, but it is also arranged to use what we and others have called "crude oil." Although in so doing they lose the advantage of immediate readiness for action obtained by using petrol to start up with, this loss is more than compensated for by the cheaper price of the fuel, which, as we have previously said, is the most important, or almost the

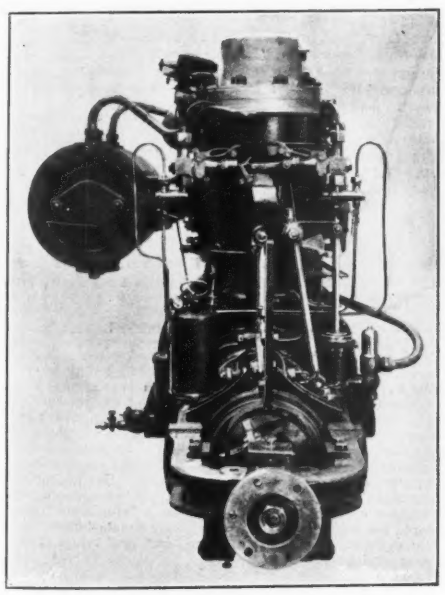


Fig. 1—END VIEW OF ENGINE

most important, point to be considered in a commercial engine.

We may perhaps digress for a moment here, and be allowed to point out that the term "crude oil" in this connection is incorrect, although it is so often used to describe what is really a distillation, and should be called solar oil. True crude oil is, of course, the oil as it flows from the wells, and is only suitable for use in engines which work on the Diesel principle after some process of purification.

The general arrangement of the engine is very similar to that of the Bolinders machine, described in THE ENGINEER of November 11th, 1910, page 506, and involves hot-bulb ignition, fuel injection direct into the cylinders, crank case compression of air only, &c., but it differs chiefly in that the possibilities of the two-cycle engine are not used to obtain a reversal of direction of motion of the engine itself, a reversing gear being fitted. The builders claim that this is a more rapid and certain method of obtaining astern motion, while it does not subject the connecting-rods and crank shaft to such severe stresses as does the "pre-ignition charge" in the Bolinders reversing engine, and to our mind there is a good deal in this contention, different as the method is from the stopping and then re-starting by compressed air in the Diesel engine.

The reversing gear fitted is of the differential bevel type, ahead motion being obtained by means of a number of wood-faced friction clutch plates, while the astern gear is obtained by gripping the case by means of a band brake which brings the bevel gear into operation, all the movements being obtained from a single lever. We must admit that we do not like the two exposed ball thrust collars which are fitted to take the thrust. The oxidisation of the balls has been found to be troublesome even in the interior of motor crank cases on cars, due to the water contained in the lubricant—bilge water must be much worse.

The lubrication of the bottom ends is obtained by small pumps drawing from adjustable sight-feed drips which are supplied by gravity from a small tank, while the cylinder wall has a groove round it, into which oil is pumped in four places so as to distribute it evenly round the piston. Thus the supply is at all times under exact command and under the observation of the engineer. The fuel passes from the main fuel tank through an easily accessible filter to a float chamber so as to provide against the differences of level in the main tank, and thence to the two oil pumps, which are

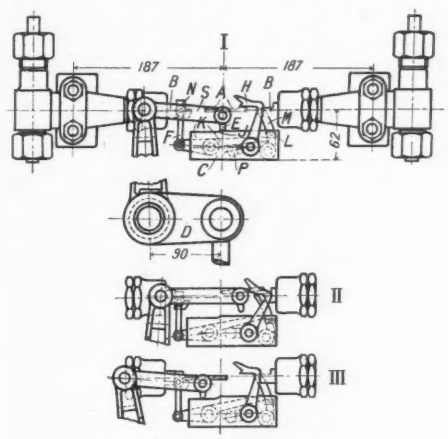


Fig. 2—GOVERNOR

very neatly driven by an excentric on the shaft. To obviate the excess flow due to the momentum of the column of oil at the end of the pump stroke, a small spring-loaded by-pass valve is fitted on the suction pipe (in place of the easily destroyed leather diaphragm), which allows any excess of oil to flow back to the float chamber, so that the fuel supply is definitely controlled by the pump. We were much interested to note that the injector nozzle in the cylinder was water-jacketed, and we were informed that this simple expedient has resulted in a very considerable economy in fuel. Water is again made use of to assist combustion. Drawn into the inlet port by the rush of air from the crank chamber, it is converted into steam by the heat of the combustion, and the makers claim thereby an increase in power of about 25 per cent., though we did not see the tests or figures upon which this claim is based. It should, at all events, tend to make a sweeter running engine, while the consumption of the larger sizes of engines—some 0.58 pints per brake horse-power per hour—is certainly low for this type of engine. We must admit, however, that we are not ourselves in favour of any system of water drip, even though the power is materially increased thereby; unless distilled water is used for the purpose there is a danger of the formation of scale in the cylinders, which may have a very destructive action, and it is difficult to ensure that the somewhat unskilled type of labour used for these engines shall not save itself trouble by using ordinary water.

The speed control of the engine is obtained from a single lever, which varies the tension of the governor spring, though we understand that in future this is to be effected by altering the length of stroke of the pumps by means of coarse pitched screws operated from the bridge.

It should first be noted that the builders have had a two-fold object in view in designing this governor—first, to control the fuel supply to both cylinders of a two-cylinder engine, so that the "bulb" shall be maintained at an equal temperature in each cylinder when the engine is running light; and, secondly, to minimise the wear on the knife edge of the "hit-and-miss" arrangement. Both these desirable features are obtained in an ingenious and comparatively simple manner, the first by so interconnecting the hit-and-miss gear that the fuel plungers of the cylinders must both be either hit or both missed in the one revolution, the second by imposing upon the knife edges only the duties of keeping the pump operating gear out of action on the comparatively few strokes when a charge is not required, instead of as is usual placing the whole of the work of opening the pumps on each stroke on this necessarily reduced surface and relieving it only when there is no work to be done. To allow of this being carried out simply, the two pumps B B—in View I., Fig. 2—are placed opposite to each other, the striking face of the second pump plunger being formed by a small hardened steel block N, which is held in position against the face of this plunger by a link F carried on the short end of a rocking lever K pivoted on a fixed block C. The motion for driving the pump plungers B is derived from a single excentric on the crank shaft through a bell-crank lever D, each plunger being depressed in turn by the reciprocation of the double-ended tappet or striker A, which has a rectangular driving face with ample surface at each end, instead of the usual knife edge, which is here found on the side instead of at the end, and indicated by the dotted line. The tappet A is guided into direct contact with the plungers of the pumps by the projection E on its underside, which slides on the face of the block C, being normally kept in contact therewith, up the tiny inclined plane J, by a spring attached to the arm S, the tension of which is adjustable by a control lever which sets the engine speed. Whenever the revolutions exceed those corresponding to the position of this lever the projection E is thrown off the face of the block C by the upward momentum imparted to it by the inclined plane, and carries the tappet A above the level of the plunger of the pump, so that no stroke is made and no fuel injected.

If this were all, however, there would be a danger that at certain speeds the tappet might not quite clear the plunger, but would slip off after only half a stroke had been made, and the wear would be excessive and the action uncertain. To meet this difficulty the lever H is provided, having a jaw or catch at the upper end, as shown, and a bell-crank extension P at the lower end, and normally kept up against a stop in the position shown—View I. of Fig. 2—by a light spring coiled round its axis. The jaw catches the knife-edge on the side of the tappet, if and when the latter is thrown up high enough, and definitely carries the face of the tappet clear of the pump plunger, so that there can be no question of half a miss—see View II., Fig. 2. The oscillation of the lever H has at the same time raised the bell-crank P at its lower end, thereby raising the long arm of the rocking lever K on to the catch L on the side of the lever M and depressing the opposite end. Thus the block N is drawn down out of the path of the return stroke of the tappet A, so that a stroke of the second pump is also missed—see View III., Fig. 2.

So long as the acceleration of the engine continues these relative positions are maintained, and both pumps continue inoperative without further movement or rearrangement of the parts. As soon, however, as the speed is sufficiently reduced, the knife edge on the side of the tappet A can disengage itself from the jaw on the lever H, and the finger E can resume its normal working along the surface of the block C, and so engage with the plunger of the first pump, and at the same time it strikes the upper end of the lever M; the oscillation of this lever disengages the catch holding up the end of the rocking lever K, which therefore drops owing to the action of a spring, and lifts the block N back again up into its normal position, where the return stroke of the tappet A can reach it and give a stroke of the second pump also, and the regular action of both pumps is resumed until the next acceleration causes a repetition of the operation.

Movement of the control lever increases the tension of the spring on the arm S, and therefore raises the speed which must be reached before the inclined plane will give the tappet sufficient momentum to leave the surface of the block; the other motions being the same. Thus it will be seen that both cylinders are cut out by a very trifling increase in the number of working parts, while the knife-edge, the part with the least surface, and yet the part which is expected to do most work in the usual way, is here only required to oscillate the arm against the pressure of a very light spring, while the parts subject to wear are very small and cheaply and easily replaced.

The mechanism is very pretty, although we are inclined to doubt whether it would fulfil all the requirements of a marine governor in the direction of preventing racing without the risk of stopping the engine in a heavy following sea, when the wave following up the emersion of the propeller would have such a powerful retarding effect on the latter. On the test bench, however, with a Walker fan as brake, we were unable to stop the engine even with the most sudden alteration of the control lever; but this, of course, does not approximate to racing conditions at sea. The engine, a single-cylinder one in this case, was, however, able to fulfil one somewhat severe test to which we put it; the lamps were extinguished and the engine was set to run at its lowest possible speed for half an hour, the governor cutting out for about four or five strokes to one working stroke. At the end of that period the control lever was suddenly set to the maximum speed, when the engine responded instantly, though it was evident that the limit of time for which an engine of this size could run under these conditions was nearly reached, the bulb showing signs of cooling owing to the small amount of heat from the explosions. The arrangement of the drive for the water pump from a rocking lever on a single excentric is very pleasing and marine engine like, while the pump itself is by this means kept well up out of the bilges, and accessible for adjustment.

Crank case inspection doors of quite small dimensions are fitted; they are suitable only for disconnecting the bottom end brasses to allow the piston to be drawn out through the top of the cylinder. The removal of a cylinder cover for this purpose,

however, only involves the taking adrift of one small pipe and the breaking of one copper and asbestos joint—and that not a water joint—so that the time occupied should not be very long, and the arrangements must be considered distinctly good. The main bearing caps are accessible, and the brasses can be taken out from outside the crank case, so that examination, at all events, is possible without much trouble.

Altogether it may be said that the long marine steam engine experience of Messrs. Goedkoop has stood them in good stead in the design of this engine, and with its low fuel consumption costs it should prove a serious candidate for fishing smacks, barges, &c., especially now that it is also being made in England by Messrs. Plenty and Son, of Newbury.

INSTITUTION OF CIVIL ENGINEERS.

ELECTRIC LIGHTING OF RAILWAY TRAINS: THE BRAKE VEHICLE METHOD.*

By ROGER T. SMITH, B.Sc., Assoc. M. Inst. C.E.

THE method of train lighting considered is that in partial use on the Great Western Railway, where axle-driven dynamos and batteries controlled by an automatic regulator are installed on brake vehicles only. The lamps throughout the train are supplied from these equipments, which work in parallel with each other, the brake vehicle equipments and the lamp wiring in the coaches dependent on them being connected electrically by through wiring coupled between coaches. There is consequently an appreciable reduction in initial cost and upkeep of plant, and, what is of chief importance from the railway point of view, increased reliability. Mr. William Langdon's paper, read before the Institution in 1891, describes his, the first, attempt to light electrically passenger rolling stock in general in place of lighting set or block trains, which were never broken up in traffic. Mr. Langdon's final method provided one axle-driven dynamo in the block part of a main line train and a battery on each of the other coaches. All coaches were electrically coupled, and when uncoupled the lighting of each coach was continued during its branch journey by means of the charged battery. For any method of electric train lighting applicable to all passenger rolling stock the alternatives are either some such method as proposed by Mr. Langdon or that every coach is "self-lit," that is to say, provided with its own axle-driven generator and battery. Other methods are either not applicable to passenger stock as a whole or unsuitable for English railways.

The first aim of any method of train lighting should be to light passenger rolling stock adequately and with reliability. Measurement and experience lead to the provision of an illumination, measured on a horizontal plane at eye-level, of 2 foot-candles in 3rd class, and 2½ foot-candles in 1st class compartments. Glare or dazzle can be minimised, if not entirely prevented, by keeping lamps out of the line of sight, by providing a white background behind the glowing filament, or by reducing the intrinsic brilliancy of the filament by enclosing the lamp in a diffusing globe or holophane globe, the latter at the same time improving distribution. The tungsten train-lighting glow lamp now replaces the carbon glow lamp, its most economical efficiency with present train lighting lamps being 1.3 watt per candle. On the average tungsten glow lamps, with a useful life of 850 hours, now have to be changed only once a year in the electrically-lit coaches on the Great Western Railway, where lamp voltage is regulated within ± 2½ per cent.

Any axle-driven system must in the first place provide a lead cell or other accumulator, so that the lamps are lit whether the train is standing or moving throughout its range of speed. In order to draw proper attention to the importance of the accumulator in train-lighting, it is both convenient and useful to look upon the accumulator as the essential element and on the dynamo as a device for making the output of the accumulator continuous throughout the hours of lighting. As typifying the accumulator the lead cell alone is considered. The two extremes among methods of charging lead cells are charging at constant voltage and charging at constant current, but a method of charging which combines the advantages of both extremes, while avoiding their disadvantages, is recommended, the charge being completely under the control of an automatic regulator set to give the proper compromise. The arrangement consists in starting with a heavy charge and gradually reducing it until, after proper gasing has taken place so as to mix the electrolyte, the charge is stopped when the cells are full, or the battery is left floating on the load while lights are on. Automatic regulation is necessary to secure a long and healthy life for the lead cell, and to reduce maintenance it is essential; when properly arranged, 10 per cent. per annum of the initial cost of the whole cell will provide for both maintenance and renewals of the plates and boxes.

The train-lighting dynamo is of secondary interest as compared with the battery, the essential element being some means of keeping the voltage constant at all speeds while permitting of its automatic variation by the regulator when required. The suspension and driving of the dynamo and the reduction of belt losses and renewals are among the chief factors in success. The automatic cut-in cut-out switch for connecting or disconnecting the dynamo from the battery should be actuated electrically, since the voltage of the latter may vary 25 per cent. from that of the former at any given speed. It is desirable that this switch should also act as an instantaneous automatic reverse-current circuit-breaker. The problem of automatic regulation has not attracted the British inventor as compared with other inventors on both sides of the Atlantic. The functions of an ideal regulator, combining in one or two instruments battery and lamp-voltage regulation, may be defined briefly as the following:—First, it must control the lamp-voltage within ± 2½ per cent. of the rated voltage of the lamps, and, within reasonable limits, must do so independently of lamp-load and entirely independently of battery voltage. Secondly, when lamps are off, the regulator must control the generator field so as to provide the full output of the dynamo for charging an empty battery; and when lamps are on, the balance of the full output must be available for charging. As charging proceeds the regulator must control the inherent regulation of the dynamo so that its voltage only rises sufficiently to give a diminishing charging current. Thirdly, with a fully charged battery and lamps off, the regulator should reduce the charging current to zero. Fourthly, with a fully charged battery and lamps on, the dynamo output must be adjusted to equal the lamp load, leaving the battery in a floating condition with current neither entering nor leaving it. The foregoing requirements can to-day be obtained combined in one piece of apparatus.

To reduce the initial cost of electric train-lighting it is of first importance to reduce the number of battery cells, since within train-lighting limits it is the number of cells to be maintained, and not their size, which counts. The number of dynamos and regulators may be reduced in the same proportion. With the exception of through coaches transferred from main to branch lines, every train on the Great Western Railway has at least one brake vehicle controlling it for traffic purposes, and all coaches which leave or join a main-line train *en route* are either brake vehicles themselves, if detached or attached as single vehicles, or, if two or more coaches are detached or attached, they are controlled by a brake vehicle. If every brake vehicle is equipped with a generator and battery, the remaining coaches being wired only, while through wiring and couplers designed to connect all vehicles together electrically are provided on every coach, a less costly method of lighting trains is assured, as compared with the equipment of every coach as a self-lit vehicle. In addition, much greater reliability is secured by working two or more dynamos and batteries in parallel. This arrangement of equipment it is proposed to call the "brake-vehicle" method, because under ideal circumstances only brake vehicles need be equipped. On the assumption that all Great Western passenger rolling stock might be equipped for electric train lighting, the percentage of brake vehicles would be 27, of dependent coaches 40, and of self-lit coaches 33 for main-line working, while for local and suburban traffic the percentage of brake vehicles would be 39, and of dependent coaches 61. If the ratio of brake vehicles to dependent coaches were as 1 to 3 and there were no self-lit coaches, the initial cost of equipping an entire rolling stock of some thousands of coaches would be reduced by about 35 per cent. as compared with self-lit equipments, and the working costs would be reduced about 40 per cent. The increased reliability due to a higher percentage of generator coaches is, however, of greater importance to the railway than reduction in cost. In addition to the electrical requirements already specified for the ideal equipment, others are specially needed for the brake-vehicle method. It is of primary importance that the dynamo should be capable of running with its brushes short-circuited, while, in addition, its output must be capable of being quickly altered by a simple adjustment to suit altered traffic conditions.

An experimental six-coach train lit on this method was run nearly continuously for two years in all sorts of traffic, varying from fast main line services to slow, stopping, local services. Two brake vehicles, equipped with 45-ampère dynamos, regulators, and 180-ampère batteries, light themselves and three dependents. A self-lit detachable coach completes the train. The Leitner system provided the only available apparatus able to meet the special conditions. All the equipments are in parallel, coupled through cables throughout the train providing for this. For the lighting circuits the through wiring and method of coupling is arranged on the loop-positive system, one regulator controlling the lamp voltage on each side of the loop. The same looped-positive brake vehicle method has been applied to two trains running on South Wales services, to two new trains specially built for the Cunard boat service between Paddington and Fishguard, and to two new trains used for Birmingham local services; and it is being further applied. The bus bar system of through wiring, a simplification of the looped-positive system, is now being adopted. By the bus-bar system greater simplicity and increased reliability are secured as compared with the looped system, but at greater cost.

The total annual cost of lighting a six-coach train on the looped-positive brake-vehicle method is as follows:—The cost of the initial equipment would be £761, inclusive of all carriage work charges; adding working costs, extra cost of locomotive power—determined experimentally—and capital charges, the total annual cost becomes:—

	£
Working costs	45
Power to drive dynamos, 1½ per cent. on £875	13
Haulage of extra weight, 1.7 per cent. on £875	15
Interest on £761 at 4 per cent.	30
Reproduction of capital in 20 years at 3 per cent. ..	23
Total annual cost of lighting a six-coach train	£126

With regard to the safety of electric train lighting, although at 22 volts, an arc can be formed between any of the metals employed in train-lighting, this arc will not persist. Provided the ordinary precautions necessary with electric circuits are taken, and suitable fuses are used and properly maintained, it is believed that complete immunity from fire risks can be ensured.

* Abstract of paper read at the ordinary meeting, Tuesday, November 28th.

FORTHCOMING ENGAGEMENTS.

TO-DAY.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Northampton Institute. A debate on "The Prospects of the Technical *v.* the Practical Man." 5.45 p.m.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.—Lecture Theatre, King's College, Strand, W.C. "Cement," Mr. Bertram Blount, F.I.C. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.—Great George-street, Westminster, S.W. "Brake-lining Coefficients of Friction," Messrs. J. and W. Legg. 8 p.m.

GEOLOGISTS' ASSOCIATION OF LONDON.—University College, Gower-street, W.C. "Note on a Maxilla of Triconodon from the Middle Purbeck Beds of Swanage," Mr. Arthur Smith Woodward, F.R.S. The following lecture will also be delivered: "On Prehistoric Paintings and Drawings in the Caverns of Northern Spain," Mr. Arthur Smith Woodward, F.R.S. 8 p.m.

MONDAY, DECEMBER 4TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 2, "The Carbonisation of Coal," Professor Vivan B. Lewes. 8 p.m.

THE SOCIETY OF ENGINEERS.—The Institution of Electrical Engineers, Victoria Embankment, W.C. "The Design of Tall Chimneys," Mr. Henry Adams. 7.30 p.m.

TUESDAY, DECEMBER 5TH.

ROENTGEN SOCIETY.—Institution of Electrical Engineers, Victoria Embankment, W.C. Paper, "The Energy of the X-ray," Professor W. H. Bragge, M.A., F.R.S., The University, Leeds. 8.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. Paper to be further discussed: "Electric Lighting of Railway Trains: The Brake-vehicle Method," Mr. Roger Thomas Smith, B.Sc. 8 p.m.

WEDNESDAY, DECEMBER 6TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Liverpool-street Extension Works of the Central London Railway.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. "British Guiana and its Founder, Storm van's Gravesande," Mr. J. A. J. de Villiers. 8 p.m.

THE INSTITUTION OF CIVIL ENGINEERS OF IRELAND.—35, Dawson-street, Dublin. "The Elastic Limits and Strength of Materials," Mr. W. E Lilly. 8 p.m.

FARADAY SOCIETY.—Institution of Electrical Engineers, Victoria Embankment, W.C. "A Redetermination of the Density and Coefficient of Linear Expansion of Aluminium," F. J. Brislee, D.Sc. "The Solution Volumes of Nitric Acid," V. H. Veley, F.R.S. "The Influence of the Physical Condition of Metals on Cathodic Over-voltage," J. N. Pring, D.Sc., and J. R. Curzon, B.Sc. "Notes on Thermostats," Professor Hugh Marshall, D.Sc., F.R.S. "Notes on Thermostats," W. R. Bousfield, M.A., K.C. "Notes on Thermostats and Devices used in connection with Thermostats," A. C. Cumming, D.Sc. In connection with this meeting there will be an exhibit of Thermostats. Dr. T. M. Lowry will exhibit Silica Mercury Lamps for Spectroscopic and Polarimetric Work. Mr. W. R. Cooper will exhibit the latest form of the Benköe Primary Battery. 8 p.m.

THURSDAY, DECEMBER 7TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS: GRADUATES' SECTION.—13, Queen Anne's-gate, S.W. Paper on "Carburation," Mr. G. M. Junner. 8 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment, W.C. "Notes on National and International Standards for Electrical Machinery," Dr. R. Pohl. 8 p.m.

FRIDAY, DECEMBER 8TH.

BRITISH FOUNDRYMEN'S ASSOCIATION.—Cannon-street Hotel. "Solidification of an Iron Casting in the Mould," Professor T. Turner, of Birmingham. 8 p.m.

ASSOCIATION OF WATER ENGINEERS.—Geological Society's Apartments, Burlington House, W. Special general meeting for the purpose of transacting special business, and, if thought fit, passing resolutions. 3 30 p.m.

THE ROYAL AUTOMOBILE CLUB.—Pall Mall, S W. "London to Brighton in Forty-five Minutes by Electric Train," Mr. Philip Dawson. The lecture will be illustrated by lantern slides and cinematograph films. 9 p.m.

FRIDAY, DEC. 8TH, AND SATURDAY, DEC. 9TH.

THE INSTITUTION OF WATER ENGINEERS.—Geological Society, Burlington House, W. First winter general meeting. Friday at 4 p.m., Saturday 10.15 a.m. For programme see page 577.

SATURDAY, DECEMBER 9TH.

BRITISH FOUNDRYMEN'S ASSOCIATION.—Holborn Restaurant. Annual Dinner.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Sixth Annual Dinner will be held at the Trocadero Restaurant, Piccadilly Circus, W. 7 for 7.30 p.m.

MONDAY, DECEMBER 11TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 3, "The Carbonisation of Coal," Professor Vivian B. Lewes. 8 p.m.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. "Wireless Telegraphy," with demonstrations, Mr. John McLaren. 8 p.m.

WEDNESDAY, DECEMBER 13TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. "Continuous Service in Passenger Transportation," Mr. W. Yorath Lewis. 8 p.m.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Methods of Dealing with Losses in Steam Plant due to Condensation," Mr. Geo. Wilkinson and Mr. J. Rendell Wilkinson. 7.30 p.m.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's gate, S.W. "Engine Design for Taking Advantage of Horse-power Rating," Mr. L. H. Pomeroy. 8 p.m.

THURSDAY, DECEMBER 14TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Indian Section. "Fisheries of Bengal," Mr. J. Travers Jenkins. 4.30 p.m.

THE CONCRETE INSTITUTE.—Denison House, 296, Vauxhall Bridge-road, Westminster, S.W. Ordinary general meeting. Paper, "Some Recent Works in Reinforced Concrete," Mr. G. C. Workman. 8 p.m.

SATURDAY, DECEMBER 16TH.

THE STEPHENSON SOCIETY.—Visit to the Central London Railway's Works and Generating Station at Caxton-road, Shepherd's Bush. Meet at Shepherd's Bush Station, 3 p.m.

MONDAY, DECEMBER 18TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 4, "The Carbonisation of Coal," Professor Vivian B. Lewes. 8 p.m.

TUESDAY, DECEMBER 19TH.

PHYSICAL SOCIETY OF LONDON.—Annual Exhibition at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Afternoon and evening.

SATURDAY, DECEMBER 30TH.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. Social Evening for the Junior Section. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Boiler Shop Design," Mr. W. J. Bennett. 6.45 p.m.

FRIDAY, JANUARY 19TH, 1912.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Halls, Glasgow. The "James Watt" Anniversary Dinner.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

The Trade Improvement.

VERY gratifying is the manner in which trade is reviving in the Midlands. The improvement appears to be gaining strength as it proceeds. December opens with most of the engineering establishments, iron and steel works, foundries, and hardware factories in full swing. Christmas prospects are excellent, and in many cases there are sufficient orders on the books to last well into the spring of 1912. Railway and shipbuilding requirements are accounting for much of the business in hand. Gas and oil engine builders are also actively engaged, whilst the orders taken recently by makers of motor vehicles of all kinds, both commercial and general, are unprecedented. Under these circumstances there is a strong demand for material, and iron and steel values exhibit an upward tendency.

Pig Iron Strong and Active.

The activity is particularly noticeable in pig iron, and quotations are consequently being raised. Large outputs are being made by the blast furnaces, and sellers on 'Change in Birmingham this week were less inclined to make concessions than for a long while past. Indeed, most of them were asking an advance upon recent terms. Staffordshire forge pig iron was quoted 49s. to 50s.; part-mine, 51s. 6d. to 52s. 6d.; best all-mine forge, 80s.; foundry, 87s. 6d.; and cold blast, 115s. Makers of all these descriptions are doing well, with good prospects. There is also a brisk inquiry for North Staffordshire forge pig iron at 51s. to 52s. or 53s., and for best at 58s. to 59s. or 60s.

Manufactured Iron: Large Outputs.

Large outputs are being made of bars and sheets. Marked bars are quoted £8 and merchant sorts £6 15s., whilst for North Staffordshire bars £7 is asked. The bar trade as a whole is better than for some months past. The sheet iron trade also occupies a good position. Plain sheets, singles, are quoted £7 12s. 6d. to £7 15s.; doubles, £7 15s. to £7 17s. 6d., and trebles, £8 5s. to £8 7s. 6d. Galvanised corrugated sheets are in better demand than recently, and are quoted £11 to £11 12s. 6d. Most of the South American markets are purchasing only quietly, but there is a good inquiry from India, Australia, and South Africa. Some satisfactory sales have of late been made by producers of gas strip, for which the Association price is maintained at from £6 12s. 6d. to £6 15s.

Steel Firms Busy.

Engineering steel continues in excellent request, with makers hardly able to give deliveries promptly enough to meet the requirements of consumers. The general market quotation for angles is £6 12s. 6d. to £6 15s., and for girder plates £6 2s. 6d. to £7 5s. Joists are quoted £6 10s., and ship-plates £7 to £7 10s. A steady business is done in semi-finished steel, with Bessemer sheet bars quoted £5 2s. 6d., and Siemens sheet bars £5 5s. It is understood that a meeting of stock-carrying steel merchants has been held in Birmingham with respect to the rebate question, and that negotiations are in progress between them and the Associated Steelmakers, but so far the proceedings have been conducted in private.

Railway Carriage and Wagon Building.

The various railway carriage and wagon building works in the Midlands have in hand some good wagon contracts from home railways, whilst it is believed that further orders will probably be given out when the labour situation becomes more settled. The demand from India and Australia is fair, but the South American orders are below normal. Taking the overseas demand as a whole, the position is hardly so good as a year ago, notwithstanding a large and growing South African inquiry.

Motor Omnibus Construction.

The Castle Works, Hadley, Shropshire, have been acquired by Messrs. W. A. Stevens, Limited, of Maidstone, Kent, who propose to manufacture a new type of motor omnibus, which has been evolved as the result of experiments made during the past four years by Mr. Tilling and Mr. Stevens. An order for 100 of the omnibuses has been placed by Messrs. Tilling, Limited. The Castle Works are almost new, and have an area of 33½ acres of freehold land and 5½ acres of roofing, with a floor area of 204,000 square feet. They are bounded by the Shropshire Union Canal and the London and North-Western Railway, from which line sidings intersect the works in all directions. A new company has been formed to carry on this undertaking, known as the Hadley Engineering Company.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Pig Iron Firmer.

THE attendance on the Iron Exchange on Tuesday was fairly well up to the average. There is certainly a stronger feeling to note in pig iron generally, but it cannot be said that either buyers or sellers are conducting business on what may be termed an extensive scale. Both English and Scotch brands close higher, and the reported announcement that higher freights will be charged is causing great uncertainty to rule in the latter. Finished iron and steel maintained full rates. In copper all classes of manufactured are dearer. Sheet lead remains unchanged, but English tin ingots are easier.

Quotations.

Pig iron: **Lincolnshire, No. 3** foundry, 53s. 6d. to 54s.; Derbyshire, 55s.; **Staffordshire,** 55s.; Northamptonshire, 54s. 10d. to 55s. 3d.; **Middlesbrough,** open brands, 56s. 10d. to 57s. 4d. Scotch: **Gartsherrie,** 63s. 6d. to 64s.; Glengarnock, 61s. 6d., (official, 62s.); Eglinton, 61s., delivered Manchester. West Coast hematite, 64s. 6d. to 65s.; **East Coast** ditto, 63s. to 63s. 6d., both f.o.t. Delivered Heysham: **Gartsherrie,** 61s. 6d. to 62s.; Glengarnock, 59s. 6d. (official 60s.); Eglinton, 59s. Delivered Preston: Gartsherrie, 62s. 6d. to 63s.; Glengarnock, 60s. 6d. (official 61s.); Eglinton, 60s. Finished iron: **Bars,** £7; hoops, £7 7s. 6d.; sheets, £8 to **£8** 2s. 6d. Steel: **Bars,** £6 15s. to £7 5s.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £7 7s. 6d.; sheets, £8 to £8 5s.; boiler plates, £7 15s. to £7 17s. 6d.; plates for tank, girder, and bridge work, £7 to £7 5s.; English billets, £5 5s. to £5 7s. 6d.; foreign ditto, £4 18s. to £5; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £75; tough ingots, £62 10s. to £63; best selected, £63 to £63 10s. per ton; copper tubes, 9½d.; brass tubes, 7d.; condenser, 8d.; brazed brass tubes, 8⅝d.; rolled brass, 7d.; brass turning rods, 7½d.; brass wire, 7d.; yellow metal, 6½d. to 6⅝d. per lb. Sheet lead, £19 5s. per ton. English tin ingots, £200 per ton.

The Lancashire Coal Trade.

There is a quieter feeling in this district both in house coal and on shipping account. There is great steadiness in slack and engine fuel generally.

The Training of Boiler-room Attendants.

In a paper on "The Effect of Smoke on Boiler Plant Efficiency," which was read by Mr. G. B. Storie at the Smoke Abatement Conference held last week in Manchester, the author emphasised what we have frequently pointed out in these columns, namely, the necessity of employing skilled men as stokers if the highest efficiency is to be obtained from steam power plants. Far too little importance has in the past been attached to the boiler room, and notwithstanding the fact that nearly three-fourths of the total cost of producing power is expended in generating steam, it is looked upon as a place of minor importance, when compared with the engine-room. The power user generally employs a skilled engineer at a good wage to take charge of his engine, and in many cases there is a skilled assistant engineer as well. Great care is exercised in the working of the engine, and the owner will fight for the last ounce to reduce its steam consumption. On the other hand, an ordinary labourer is, as a rule, considered quite good enough to take charge of a battery of four boilers burning about £3000 worth of coal per annum. From an economic point of view this is an entirely erroneous idea and handicaps the steam plant to no small extent when comparisons are made with other forms of power. An intelligent man skilled in the art of firing and working boilers is one of the most valuable assets in the operation of a steam plant. Better methods of instructing boiler-room attendants are necessary. Lectures to firemen have been instituted in Manchester and other centres of industry, but these do not go far enough, and Mr. Storie holds the opinion that nothing short of a complete course of training with practical demonstrations by an expert fireman will meet the case.

A Minimum Wage for Miners.

At a meeting of the Lancashire and Cheshire Coalowners' Association held in this city on Tuesday last, it was decided to confirm the resolution adopted at the previous joint meeting held on November 8th, in reply to the demand for a minimum wage of seven shillings per day. This resolution states that "inasmuch as the proposal would involve a violation of the conciliation board agreement, the coalowners are unable to agree to it." The coalowners are, however, prepared to continue negotiations for improved machinery for ascertaining the additions to be made to the collier's earnings where he is unable to earn a fair day's wage in consequence of some abnormal conditions in his working place.

Cotton Weavers' Wages.

Representatives of the North and North-East Lancashire Cotton Spinners' and Manufacturers' Association and the Northern Counties (Operatives) Weavers' Amalgamation held a conference in Manchester on Tuesday to consider the demands for an advance of wages from the weavers. It was mutually agreed that the meeting should stand adjourned until January 5th next, when the employers will give a definite reply to the application. There has not been any dispute of importance in this branch of the textile trade since 1878, when there was a 10 per cent. reduction in wages. There have, however, been several changes in the rates of pay since that date, and it is considered probable that the present question will meet with an amicable settlement.

Textile Machinery Trade.

A ray of hope for an improvement in the spinning machinery trade emanates from the announcement that the Park and Sandy Lane Spinning Company, Royton, near Oldham, has decided to build a second mill to contain from 80,000 to 100,000 mule spindles.

Technical Education.

The Manchester Education Committee decided on Tuesday last that on and after April 1st next, when Mr. Reynolds' resignation will have taken place, one director shall undertake the control of both the elementary and higher branches of education. Mr. Wyatt has been appointed to the joint office at a salary of £1250 per year, and a principal to the School of Technology is to be appointed with a salary of £1000 per year. There have hitherto been two directors of education in Manchester, Mr. Reynolds being responsible for the higher, and Mr. Wyatt for the elementary branches.

Lancaster Tramways.

At a meeting of the shareholders in the Lancaster and District Tramways Company, held last Saturday, the chairman, Mr. A. Bell, said the present horse traction system cost 13d. per mile to operate, and that the directors would consider in the immediate future the desirability of adopting electrical or petrol traction.

BARROW-IN-FURNESS, Thursday.

Hematites.

During the past week the tone of the hematite pig iron market has improved somewhat, and altogether there is a better feeling in the trade than of late; not that anything like a boom is expected—those seem to be things of the past—but there is some evidence of a fuller demand for iron on the part of some users. Steel makers locally are steady in their demands for iron, and take iron direct from the furnaces, but steel makers who pay attention to ship plates and other steel shipbuilding material have larger wants. The make of iron remains unchanged, and, as it has been on the big side for a while, it is not considered likely that any additional furnaces will as yet be put into blast. In prices there has been an upward movement, and warrants changed hands on Monday at 63s. per ton net cash, which is an advance of 1s. 6d. per ton on the week. Makers are quoting 63s. to 64s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron, and special sorts of iron, for which there is a steady demand on home account, but little on foreign, are quoted at 68s. to 70s. per ton. Stocks of warrant iron are unchanged on the week at 51,764 tons.

Iron Ore.

For iron ore there is a steady demand locally, a demand which is likely to be increased if the output from some of the furnaces is pressed. On general account a good steady trade is being done, Scotland being a good buyer, and iron ore is being sent from Barrow into Dee shipping places. The value of good average sorts of native ore remains at 10s. to 12s., and best qualities are at 20s. per ton net at mines. Spanish ores are in good regular demand at 20s. per ton delivered for best qualities. Irish ores are not in very good demand locally at present.

Steel.

The steel trade presents no new features. In West Cumberland the rail mills at the Moss Bay Works, which are owned by the Combine, are in marked activity, and a big output of rails is being maintained. These are for the Australian Colonies, and sufficient orders are held to keep the works at their present activity well into the spring. At Barrow the rail mills are also busy. Here, again, colonial contracts are held, and deliveries are now being made from Ramsden Dock to Adelaide. The new business on offer whilst not being large is fairly satisfactory. Heavy sections of rails are at £5 12s. 6d. to £5 15s. per ton. Tin bars are in fair business, and the hoop mills are busy. Nothing is being done in steel shipbuilding material at Barrow. The demand for this class of steel has materially increased of late.

Shipbuilding and Engineering.

These trades are busy in every department. There is no official confirmation of the placing of the battleship contracts with Vickers Limited and Beardmore. The reply of Vickers was that it was premature. The Chinese training cruiser built at Barrow is now undergoing her trials. Boilermakers and ironfoundries are very busy.

Fuel.

For coal there is a steady demand at 12s. to 16s. per ton for good steam sorts. Coke is in good demand at 20s. 6d. per ton delivered for East Coast sorts.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

General Conditions.

LOCAL manufacturers continue to report some pressure from consumers for the execution of orders promptly. Fresh business is also on a very regular scale, and it is evident that the material is wanted for present requirements. There is, however, nothing like any big accumulation of work in the hands of manufacturers, who state that in general open market work they have not actually booked very far ahead. But the daily inflow of orders is steadily maintained at a level which enables them to keep their establishments on full time in all departments. The scarcity of railway rolling stock has stimulated the wagon-building industry, and manufacturers of various castings, springs, axles, and other parts are in receipt of fairly good orders, not only from the home railway companies, but on foreign and colonial account. It is highly probable that the requirements of the railways may be maintained for a considerable time to come, but at the moment there is not sufficient pressure to warrant any large or general advance in prices. Still the work is remunerative. The departments engaged in the manufacture of armament material and other high-class specialities remain fully occupied, and a few shell orders have just been received by the Sheffield firms from the home Government, which will provide additional work for some time ahead. At the annual meeting of the Midland Iron Company the chairman stated that at the present time the iron trade was certainly in a very much better condition than it had been for a considerable period.

The Coal Trade.

Although the steam coal trade is quieter, all the pits in the South Yorkshire district are working full time, and the production is being disposed of at prices ranging from 9s. 9d. to 16s. 3d. per ton at pits. The shipping season proper is about finished, but owing to the mild season there is still a little business with the near Baltic ports, and coastwise shipments are good. Generally speaking, where collieries are well sold under contracts, they are holding out for full prices on any supplies they may have available for the open market, but in other cases there are some spot lots on offer at cheaper rates. There is no falling off in the demand for industrial consumption, and a good tonnage is being picked up by the railway companies for stocking purposes. There is a strong demand for gas coal, full contract tonnages going out of hand for home works.

Slacks.

Values of slacks are very firm, owing to the keen demand from the Lancashire cotton mills and from large local manufacturing concerns. On the whole the general demand for manufacturing purposes has increased, and contracts are being renewed on the higher basis noted in our last, viz., 6d. to 9d. above expiring contract figures. Current prices:—Best washed smalls, 5s. 9d. to 6s. 3d.; best hand slacks, 5s. 9d. to 6s.; seconds, 4s. 3d. to 4s. 9d., all per ton at the pits.

Coke.

Furnace coke is in considerable demand, and prices are hardening. New contracts are being made on the basis of 12s. 3d. to 12s. 6d. per ton for bee-hive coke, with second qualities about 6d. per ton less. These prices are above the rates lately ruling.

House Coal.

The house coal trade shows very little change. The collieries are fairly well provided with orders, especially for best coal. Some reaction was, of course, fully expected after the recent feverish activity, as we foreshadowed at the time; but although prices are not so firm, there is by no means an all-round reduction. Collieries appear to be refraining from pressing sales in the hope that colder weather may stimulate the demand once more.

Pig Iron.

The upward trend of pig iron prices continues. A fair business has again been done this week in both hematite and common iron. Some sellers of East Coast hematite have raised their prices further, but the general market quotation is 69s. net for prompt and 70s. for forward business. At its meeting last Friday the Lincolnshire Ironmasters' Association left the official rates unaltered as given below, but some of the makers were not selling under premiums of from 1s. to 1s. 6d. per ton. Derbyshire iron is unchanged, despite the fact that owing to labour troubles with the local foundries there is a larger supply on the market. Current quotations:—Lincolnshire, No. 3 foundry, 50s. 6d.; ditto, forge, 49s. 6d.; ditto, basic, 52s.; Derbyshire, No. 3, 50s. 6d. to 51s.; ditto, forge, 48s. 6d. to 49s., all per ton delivered Sheffield or Rotherham. Hematite prices are:—East Coast mixed numbers, 69s. to 70s. net; West Coast ditto, 74s. to 76s., less 2½ per cent. discount. Bar iron remains very steady, with a prospect of a further rise of 5s. per ton. Bar iron, £7; and hoops, £7 5s. The billet trade is very active, and prices remain: Siemens, £7 5s. to £7 10s.; basic, £5 5s. to £5 10s.

Finished Trades.

Activity characterises practically every branch of the steel trades. The foundries are particularly well off. We refer above to the condition of the heavy branches, but in the lighter steel sections manufacturers report well filled order books. Makers of engineers' tools, files, saws, agricultural tools, edge tools, tool steel, and special steels for motor engineers, are extremely busy. Foreign and colonial orders for these products are on a good scale, but the revival that set in recently in the home market is particularly welcome. The cutlery branch is one of the most active at present, and the various grades of workmen are agitating for more uniform rates of pay, as a result of the busier conditions, and also owing to the fact that the employers recently advanced selling prices by 5 per cent.

New Collieries.

The Manvers Main Collieries Company, Limited, Wath, near Doncaster, has secured, and is about to open up, 2000 acres of coal lands at Barmborough, a village about two miles from its present pits. It is expected that the Barnsley bed will be reached at a depth of about 550 yards, and the Parkgate seam at about 800 yards. The new colliery is to be laid out to produce between 3000 and 4000 tons of coal per working day.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

THE upward movement in prices of Cleveland pig iron, which was so noticeable a feature last week and the previous week, has not been maintained this week, though in the legitimate market it cannot be reported that there is any adverse circumstance; in fact, the position and prospects are as healthy and satisfactory as ever. Yet Cleveland pig iron warrants, which last week touched 48s. cash buyers, have dropped to 47s. 5d. this week, mainly because of the manipulations of speculators in warrants. When prices were rising a good many of the outside public seem to have been tempted to have a little "flutter" and bought rather freely. When 48s. was reached, a number of them proceeded to sell out so as to secure profits. That caused the upward movement to cease, and brought about an easing which led to a rather keen rush to sell, and further weakened the prices. Legitimate traders are generally looking on, as the decrease in quotations is expected to give place shortly to another period of advancing prices. Makers are very well situated as regards orders and have only small stocks, so that they are not following the decline in the quotations for warrants. They maintain 48s. per ton as their minimum for early f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron, and some quote even 49s. and 50s., and indeed have sold at these higher figures. Odd lots have been sold by second hands for prompt delivery, however, at 47s. 10½d., and consumers say they have bought at 47s. 9d. No. 1 for prompt f.o.b. delivery is at 51s. 9d., No. 4 foundry at 47s. 6d., No. 4 forge at 47s. 3d., and mottled and white at 47s. For delivery over the first quarter of 1912 at least 6d. more than the above figures has to be given, and for the second quarter quite 1s. more. It is a good feature that consumers are prepared to pay more for forward than for prompt delivery. Makers have secured a good many orders during the last three weeks, and are rather independent in respect to prices. They are certainly not so keen to sell for spring delivery as consumers are to buy.

Hematite Pig Iron.

Reports from producers and merchants relative to the condition of the East Coast hematite pig iron trade are very favourable, the demand is improving substantially, and prices continue to move upwards; in fact, they are now quite 2s. per ton more than they were a month ago, and further advances are looked for. There has been no "set-back" since the upward movement in quotations commenced, and the position of makers is quite encouraging. They are better off than the producers of Cleveland pig iron, in that they have not to contend against the competition of warrants, for there are now no East Coast hematite warrants, and thus the operations of speculators do not interfere with legitimate trade. The situation has also improved, in that the competition of scrap has largely abated; it is neither so plentiful nor so cheap as it was a short time ago. West Coast hematite warrants have risen in price; sellers, who recently were accepting 61s. cash for them, now ask 63s. 6d. Consumers are showing more anxiety to buy for delivery over the first half of next year, as it seems probable that they will not do any better in the matter of prices if they wait. East Coast hematite mixed numbers, which at the beginning of November could be got readily at 60s. 6d. per ton for early delivery, have this week been rather freely bought for delivery December and January at 62s., but now 62s. 6d. is

the regular figure for early delivery, 63s. for delivery over the first quarter of 1912, and 63s. 6d. for delivery over the first half of the year, though makers are not keen on selling so far ahead as the end of June next when there is a marked upward movement appearing in prices.

Iron-making Materials.

While the prices of pig iron have gone up the cost of production is also increasing probably as much as the selling price of the iron, for both ore and coke have been substantially advanced in value. It is reported that it would be difficult now to get Rubio ore for early delivery at Teesside wharves under 21s. per ton, and merchants are quoting from 21s. to 21s. 6d. per ton. One reason for the increase is the rapid rise in the rates of freight. Not so long ago the rate from Bilbao to Middlesbrough was 4s. 3d. per ton, and for a long time this year 4s. 7½d. was the figure, but now 6s. 6d. must be and has been paid. There is some difficulty in chartering steamers even at that, for shipowners have become very independent, and practically get not only their own prices, but make their own conditions as to despatch and discharging. It is indeed many years since they were so much masters of the situation, but they have not the least difficulty in getting cargoes for their steamers, and offers of boats are quickly snapped up. It was thought that the close of the Baltic season, which is at hand, would have had some influence in easing the shipowners' demands, but, so far, it seems likely that they will more than hold their own over the winter. Coke is in very good request both for home consumption and for export, and manufacturers are taking full advantage of their opportunities, for they have put up their quotations, and this week have advanced their quotation for furnace coke for early delivery at Middlesbrough to 15s. 6d. per ton, where not so long ago they were accepting 14s. 6d., while they are asking and getting 16s. per ton for supplies to be delivered over the first half of 1912. Foundry coke is at 17s. to 18s. 6d. per ton, and higher rates are expected. Limestone has gone up in price, and delivered at Middlesbrough furnaces 4s. 6d. to 5s. per ton must be paid. The Cargo Fleet Iron Company, Middlesbrough, has terminated the lease of its limestone quarry at Mickleton in Upper Teesdale on account of the increasing cost of working and the growing unsuitability of the limestone for blast furnace purposes, due to the working out of the best and most accessible stone. It is now dismantling the machinery at the quarry.

Realised Price of Manufactured Iron.

The Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England have been informed by their accountants that the average net price realised by the producers for the finished iron delivered during September and October last was £6 5s. 3.25d. per ton, or 1s. 2.38d. less than in the previous two months. This does not under the sliding scale carry with it either an advance or reduction, so that the wages in the North of England manufactured ironworks will remain the same for December and January as they have been in the past two months, and, indeed, as they have been for fully a year. It may be stated that the £6 5s. 3d. named above is the lowest realised average price that has been reported since November-December, 1905. On the other hand, the deliveries during the two months were the largest that have been announced for over four years—since July-August, 1907, in fact. The average price realised for iron rails was £5 8s. 2d. per ton; for iron plates, £6 2s. 4d.; for iron bars (which form 80 per cent. of the production), £6 5s. 10d.; and for angles, £6 8s. 8d. per ton.

Manufactured Iron and Steel.

The improvement in business in the finished iron and steel industries is more pronounced than ever, and the mills in the North-East of England are employed to their fullest capacity, with one exception—the South Durham Steel and Iron Company has not yet reopened its Moor Works at Stockton, which have been idle since the autumn of 1907, but the firm produces more steel at its other two works than it ever did when all three were employed. The company, however, contemplates enlarging its West Hartlepool works. Prices are well maintained. Steel ship plates are quoted £6 15s. less 2½ per cent., delivered at any shipyard on the North-East Coast, but a rebate of 5s. per ton will be allowed where the consumer does not obtain any of his steel from manufacturers outside the associated firms. Iron ship plates are at £6 10s. less 2½ per cent., delivered at North-Eastern shipyards, but the output is now very small. Steel ship angles are at £6 7s. 6d., iron ship angles at £7, steel bars at £6 5s., iron bars at £7, steel hoops at £6 12s. 6d., steel strip at £6 10s., steel joists at £6 10s., steel sheets at £7 7s. 6d., iron ship rivets at £6 5s., all less 2½ per cent. Galvanised and corrugated iron or steel sheets are on the basis of £11 5s. for 24 gauge, less 4 per cent. delivered f.o.b. Heavy steel rails are at £5 12s. 6d., and cast iron railway chairs at £3 12s. 6d., both net f.o.b.

Coal and Coke.

The coal trade is uncommonly brisk, and as far as the demand for bunker coal is concerned, it is unprecedentedly active, both for steamers at home and for dispatch to coaling stations abroad. On account of the strong rise in prices and the probability of further advances, stocks are being replenished in all quarters, and there are not vessels enough available to carry all that is to be sent. Rates of freight are going up rather sharply, and in all directions, notwithstanding the near approach of the end of the Baltic season. Ordinary Durham unscreened bunker coals are sold at 11s. to 11s. 3d., while best are at 12s., and there have been sales at 12s. 6d. and 13s., the best prices this year. Higher prices are quoted for next year's delivery than for prompt. Best coking coal is up to 11s. Foundry coke is firm, at 17s. to 18s. 6d. per ton f.o.b.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

Good Business in Pig Iron Warrants.

THERE has again been an active pig iron warrant business this week in Glasgow Exchange. The highest improved prices have not been maintained; but it should not, perhaps, excite surprise that, after rising 1s. 6d. per ton, prices should occasionally suffer a reaction. It is understood that a large proportion of the recent buying has been on the part of merchants and consumers, but the speculative element also has had a footing in the market, and to it is mainly to be traced the occasional depressions in prices. Since last report business has been done in Cleveland warrants from 48s. to 47s. 7½d. cash, 48s. 4d. to 47s. 11½d. one month, and 48s. 9d. to 48s. 6d. three months. Transactions in Cleveland have also occurred at 47s. 8½d. for delivery in nine days, and 48s. 1½d. and 48s. 2d. twenty-one days.

Scotch Pig Iron Trade.

An improved business has taken place in Scotch pig iron both on local and English account, the export demand likewise showing a little more animation. The advanced prices of last week are well maintained. Govan and Monkland, f.a.s. at Glasgow, Nos. 1, are quoted 57s.; Nos. 3, 56s.; Carnbroe, No. 1, 61s.; No. 3, 57s.; Clyde and Calder, Nos. 1, 62s. 6d.; Nos. 3, 57s. 6d.; Gartsherrie and Langloan, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee, No. 1, 63s.; No. 3, 59s.; Coltness, No. 1, 82s. 6d.; No. 3, 58s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 56s. 6d.; No. 3, 55s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 59s.; Dalmellington, at Ayr, No. 1, 57s. 6d.; No. 3, 55s. 6d.; Shotts, at Leith, No. 1, 63s.; No. 3, 58s.; Carron, at Grangemouth, No. 1, 64s.; No. 3, 59s. per ton. There are 84 furnaces in blast, compared with 86 at this time last year.

Hematite Pig Iron.

A quantity of Cumberland hematite warrants changed hands in the Glasgow Exchange this week at 63s. cash, this being an improvement of 9d. per ton on the former price. Outside of the warrant market a considerable demand has been experienced for hematite, and the Scotch product is now 1s. higher, at 66s. per ton for delivery at West of Scotland steel works.

The Malleable Iron Trade.

The malleable iron trade of the West of Scotland is comparatively well employed at present, but it has been found very difficult to obtain any advance in prices, notwithstanding the rise in values of coal and pig iron. An appeal has been made by several of the makers to the Chancellor of the Exchequer against the fresh burden proposed to be put on the industry by the Insurance Bill. They state that, owing to the severe foreign competition and the high on-cost rates, it will be impossible to provide for the insurance charges, except at a loss to the makers, and they suggest that the money be raised by an additional income tax on all persons earning over 25s. per week, along with a contribution from the National Exchequer. Mr. Lloyd George has replied, through his secretary, that the very fullest consideration has been given to alternative proposals, and the most careful attention given to the views of employers of labour. Mr. Lloyd George and his advisers, it is added, have spent about two years on the scheme, and to adopt the proposals made to him would necessitate its entire recasting.

Wages and Rebates in the Steel Trade.

The Scotch steelmakers have intimated that they claim a reduction of 2½ per cent. on the wages of millmen and steam men, their object being to bring about a uniformity in the sliding scale by assimilating the basis of the scale for steam men and millmen to that by which the wages of smelters are arranged. Meetings of the workmen have been held at which strong opposition has been shown to the proposal. The men have conceived the idea that the object of the employers is to throw upon the workmen the loss that will be incurred by the rebate of 5s. per ton now offered to consumers of steel. No doubt the employers will have a good answer to this allegation when the subject comes before the Conciliation Board for discussion. A fair amount of fresh business is reported to have been placed within the last few days, although it is not pretended that the aversion to the rebate system has yet been anything like fully overcome. Specifications under existing contracts have been coming to hand freely, and the steel works are generally busily employed. There is a good amount of miscellaneous work in hand, and contracts for a variety of steel material are at present under consideration.

The Coal Trade.

The coal trade is in a healthy condition, and not only are former prices maintained, but further advances are impending for special classes of coal. Included in these is splint coal, for which the demand is at present exceptionally large, and an increase of 1s. per ton has been intimated on deliveries, beginning with December. It is understood that inland consumers are chiefly interested in this advance, as the shipment prices had already gone ahead of the monthly contract rates. Small hard coals of all kinds have been hardening, and prices are expected to rise presently 3d. to 6d. per ton. The better kinds of ell coal and splint are quoted 11s. 3d. to 11s. 9d., and steam coal 10s. 3d. to 10s. 9d. per ton. On account of the open weather, the inland trade in ordinary household sorts has not felt any special pressure for delivery, and it is believed that prices will not be further advanced at present.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade.

BUSINESS was reported on Saturday to be coming in a little more freely, but ready boats were not numerous enough to reduce the large stocks of coal which have been steadily accumulating, showing that labour questions have not interfered with production. The colliers have continued to work well, one incentive being the burden they have incurred, and another the approach of the Christmas holidays. The Italian Government, not content with the large orders placed, has continued to put in fresh ones, and any day may bring the particulars of our own Navy requirements. On 'Change Tuesday colliery owners were of opinion that a busy time was at hand. The little labour difficulty with the tippers has been settled, weather propects were more favourable, and tonnage was coming in at a fuller rate. Latest news: Interest is being aroused in Wales by the rumour that rivalry upon an increased scale may be expected from the Kent coalfield, which speculators threaten to bring into competition with the steam coals of Wales. It is asserted that a tract of about 3000 acres has been acquired. Locally, it is of more interest to record that steady developments continue in Wales. The sinking operations begun at Gilfach Goch by Mr. D. A. Thomas and Mr. W. Llewelyn have resulted in the discovery of the 6ft. seam, at a depth of about 400ft., in the same shaft as that in which the 4ft. seam was won a short time ago. It is 6ft. 6in. in thickness—a splendid section, with a good roof, and is expected to provide work for 3000 colliers, additional, in the Gilfach Valley. Monmouthshire coals are reported to be stiffening, and this applies generally to December.

Quotations.

Mid-week the steam coal conditions were again strong, despite a little irregularity for immediate shipment. A number of colliery owners were reported on 'Change to be declining business for next week and later deliveries. They said that with such full order books they are unable to take risks of the future even at higher figures than current. One great complaint is that owners are unable to get tips to load the vessels that are waiting. Probably an effort will be made to extend loading facilities. Latest quotations: — Best Admiralty large steam, 17s. to 17s. 3d.; best seconds, 16s. to 16s. 9d.; ordinaries, 15s. to 15s. 9d.; best drys, 16s. to 16s. 9d.; ordinary drys, 15s. to 15s. 6d.; best washed nuts, 14s. to 15s.; seconds, 13s. 6d. to 14s. 6d.; best washed peas, 12s. 6d. to 13s. 6d.; seconds, 11s. to 12s.; best bunker smalls, 8s. to 8s. 6d.; best ordinaries, 7s. 6d. to 7s. 9d.; cargo smalls, 6s. to 6s. 9d.; inferior smalls, 5s. 3d. to 5s. 9d.; best Monmouthshire black vein, 15s. 3d. to 15s. 9d.; ordinary Western Valley, 14s. 6d. to 15s.; best Eastern, 13s. 9d. to 14s. 3d.; seconds, 13s. 3d. to 13s. 6d. Bituminous: Very best households, 17s. to 18s.; best ordinaries, 14s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. to 17s. 6d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 9d. to 10s.; No. 2 Rhondda, 12s. 6d. to 13s.; through, 9s. 9d. to 10s. 3d.; smalls, 6s. 3d. to 6s. 9d. Patent fuel, 16s. to 17s. Coke, 24s. to 25s., special foundry; foundry, 17s. 6d. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 29s. to 30s., ex ship.

Newport (Mon.) Coal.

Sellers last week were willing to accept easy terms for spot shipment, but held firmly for forward, and both large and small were fully 3d. per ton dearer. Mid-week conditions continued to improve. For December shipment all sellers were well booked, and higher values were named for large and small; house coals firm; patent fuel strong; coke dull; pitwood scarce. Best black vein, 15s. to 15s. 6d.; Western Valleys, 14s. 3d. to 14s. 9d.; Eastern, 13s. 6d. to 14s.; other kinds, 13s. to 13s. 6d.; best smalls, 7s. 3d. to 7s. 9d.; seconds, 6s. 9d. to 7s.; inferiors, 6s. to 6s. 6d. Bituminous: Best households, 13s. to 17s.; seconds, 15s. to 15s. 6d. Patent fuel, 16s. to 16s. 6d. Coke: Foundry, 17s. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 20s. to 30s.

Swansea Coal.

Shipments of coal and patent fuel were active, and, despite the storms, the pressure for Welsh coal was maintained, and the total traffic was above the average. Mid-week:—Anthracite remained strong; demand well sustained, at firm values. Swansea in big demand; scarce even at high value. Red vein improved values, marked up slightly; nuts and cobbles firm, rubbly culm weak; duff a little better; steam coal unchanged. Latest prices:—Best malting, 21s. to 23s. net; seconds, 19s. 6d. to 20s. 6d. net; big vein, 18s. 6d. to 19s. 6d., less 2½; red vein, 12s. 6d. to 13s. 6d., less 2½; machine-made cobbles, 19s. 6d. to 22s. 6d. net; Paris nuts, 22s. 6d. to 25s. net; French nuts, 22s. 6d. to 25s. net; German nuts, 23s. 6d. to 25s. 6d. net; beans, 19s. 6d. to 22s. 6d. net; machine-made large peas, 11s. 9d. to 13s. 3d. net; rubbly culm, 5s. 3d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal: Best large, 17s. to 18s. 3d.; seconds, 13s. 6d. to 14s. 3d.; bunkers, 10s. to 11s.; small, 6s. to 7s.; all less 2½. Bituminous: No. 3 Rhondda, 17s. to 18s.; through, 13s. 9d. to 14s. 3d.; small, 10s. 3d. to 11s., all less 2½; patent fuel, 14s. 6d. to 15s. 3d., less 2½.

Iron and Steel.

Practical evidence has been afforded of late that these trades are reviving, and no better proof could be afforded than the concession of back pay to the Dowlais workmen by Guest, Keen and Co. It will be remembered lately that distinct promise was given to the workmen that steps were being taken to give an advance of wages. This has now been accomplished, and on Saturday last was carried out. The Dowlais workmen number about 2000 men, and the distribution of back pay per workman totalled several pounds in many cases. In all, the increase per annum is expected to reach £1200. A settlement has been brought about with the Pontardawe ironworkers who left work without giving the necessary legal notice. They were in due course summoned, but the prosecutor showed a disposition to deal mercifully with the offenders, though their action entailed serious loss. On Monday the offenders agreed to a summary judgment, and fines of £3 5s. were inflicted. There was quite a busy period at Dowlais last week, and the men carried on work with more animation consequent, of course, on the satisfactory arrangements with the management. The whole of the steel and ironworks had full time. Bessemer and Siemens furnaces had a large tonnage of crude steel, and a substantial total of rails and sleepers came from the Goat Mill. The Big Mill was chiefly occupied with light steel rails, angles, and fish plates. Blast furnaces busy, and a quantity of pig iron was put into stock. There was a good demand at Llanelly for bars, and all furnaces were in full operation. Latest quotations, Swansea Metal Exchange:—Pig iron, hematite mixed numbers, 63s. cash, and 63s. 3d. month; Middlesbrough, 47s. 8d. cash, 47s. 11½d. month; Scotch, 53s. 9d., 54s. month; Welsh hematite, 69s. to 70s. delivered; East Coast hematite, 68s. c.i.f.; West Coast, 68s. c.i.f.; Steel bars, Siemens, £5; Bessemer, £4 15s. to £4 17s. 6d.; iron ore 19s. 6d. to 20s.

Tin-plates.

A prominent feature of business at Swansea last week was the inauguration of direct shipment of tin-plates from Swansea docks to India and other foreign countries. Additional mills are being projected at the King's Dock, and several firms are stated to be on the eve of increasing present facilities. Last week the shipment of tin-plates was 169,814 boxes, and the quantity received from works was 106,150 boxes. Stocks in the dock warehouses and vans were reported at 68,769 boxes. Latest:—The price of tin-plates at the last report continued to advance, and every indication was given that the price will be upheld for some time, with the probability of higher figures. It is stated that the margin between the selling price and the cost of production is so small that the leading manufacturers are compelled to advance their prices, and there is more disposition on the part of buyers to pay the advance. Latest quotations:—Ordinary plates, 13s. 7½d. to 13s. 9d.; ternes, 24s. 6d.; C.A. roofing sheets, 30 g., £9 per ton; big sheets for galvanising, 30 g., £9 per ton; finished black plates, £11 to £11 5s.; galvanised sheets, 24 g., £11 10s; block tin, £201 cash, £120 three months. Other quotations:—Copper, £57 17s. 6d. cash, £59 12s. 6d. three months. Lead: English, £16 8s. 9d.; Spanish, £15 18s. 9d.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 22nd.

STRUCTURAL shapes have declined another 1 dol. per ton, the minimum being 1.10 as against 1.40 two months ago. The dulness which has prevailed in shapes is indicated by the fact that the American Bridge Company, which usually employs 1700 men on its plants, is now employing only 400. This condition promises to be changed very soon. Contracts are pending to-day for 30,000 tons of shapes at eastern mills, while it is reported over three times that amount of material has been contracted for at western mills. Large orders have been placed for steel rails, one authority placing the total amount placed at 200,000 tons, but others think this largely excessive. These figures may possibly include pending inquiries, which are certain to result in orders, the total of inquiries now on the market aggregating 300,000 tons. The total of this year's rail business will probably equal that of last year. The railroad companies have been putting off contracts for cars until they could wait no longer. Very heavy orders have been placed, and more are in sight. This activity in car building has, of course, helped the market wonderfully. In eastern markets orders are looking up. The general outlook in plate and shapes is very much better. In other and lesser lines there is not much for comment. Bar mills are fairly busy. Sheet mills are gaining a little. Wire products are exceptionally dull. Tin-plate is inactive, and something like half the capacity is reported idle. A decided increase in plate mill orders is looked for. In a general way business is more active in western than in eastern markets. The American Steel Foundry Company has bought 10,000 tons. Crude iron is dull so far as the general run of buyers is concerned. Southern furnaces are actively soliciting business. The visible supply of copper in the United States was 134,997,642 lb. The European visible supply on November 15th was 133,000,000 lb. American consumers are acting indifferently.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Kitson Empire Lighting Company, Limited, of Stamford, has registered the trade-mark Kelite, and asks us to state that this will in future be stamped on all lamps and spare parts made by it.

MR. E. V. JOHNSON, late technical representative for Willans and Robinson, Limited, in South Wales, has joined the firm of W. V. Waite and Co., Limited, Cardiff.

MR. W. WALTER HUGHES has now terminated his connection with the British Westinghouse Electric and Manufacturing Company, Limited, and will, in conjunction with his associates, henceforth devote his entire time to private practice as an electrical, mechanical and mining engineer.

ALFRED HERBERT, Limited, of Coventry, announce that Messrs. Oscar Harmer, Joseph Pickin, John Milburn, W. H. Herbert, P. V. Vernon, and Thomas Woof, all of whom have for many years been actively associated with the management of the company, have been appointed departmental directors. Mr. Alfred Herbert continues as chairman and governing director.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(From our own Correspondent.)

Rheinland-Westphalia.

A SATISFACTORY condition is reported to prevail on the pig iron market. Sales during the week have been lively. The foundries are now buying their requirements for the first two quarters of 1912, and small purchases for delivery till the end of this year are also being freely made. In Siegerland iron ore a comparatively quiet trade is being done, and stocks continue large. The malleable ironworks are well employed on home and foreign account. Present rates for raw bars are M. 87.50, for billets M. 100, and for raw plates M. 102 50 p.t., all in basic. Export quotations for raw bars are M. 83 to M. 84 p.t. free at sea port. Increasing employment is stated to prevail in merchant bars, causing rates to stiffen; sales for 1912 are now being effected. The average quotation is M. 105 to M. 107.50 p.t., but even M. 110 p.t. has been asked, and prices do not go below M. 105 p t. Occupation at the hoop mills has been increasing, foreign demand showing an improvement. Orders continue to come in freely in the plate trade, heavy sorts being especially well inquired for, and rates exceed the convention prices. Tank plates stand at M. 125 to M. 127.50 p.t., construction plates M. 128 to M. 130, boiler-plates M. 135 to M. 136 p.t. On November 4th a meeting of the Plate Convention was held, when an immediate rise of M. 5 p.t. for all dimensions was resolved upon. On the 25th inst. another meeting was held, when the prolongation of the convention was taken into consideration. Sheets are brisk, prices remaining unchanged. Wire and wire nails show more firmness than formerly, and in the pipe industry employment continues lively, but rates are weak as before. Latest quotations of the Düsseldorf 'Change show a rise of M. 2 p.t. for heavy plates and for boiler-plates.

List Prices.

The following are the current list rates per ton free at works:—Raw spathose iron ore, M. 11.60; roasted ditto, M. 16.50; Nassau red iron ore, 50 per cent. contents, M. 14.50, net at mines; white forge quality pig iron, M. 72; Siegerland brands, M. 62; Rhenish-Westphalian ditto, M. 62; steel iron, free Siegerland, M. 65; free Rheinland-Westphalia, M. 66 to M. 67; German Bessemer, M. 74.50; Luxemburg forge pig, free Luxemburg, M. 48; Luxemburg, foundry pig, No. 3, M. 52.50 to M. 53; German foundry pig, No. 1, M. 70.50; the same, No. 3, M. 67.50; German hematite, M. 74.50; good merchant bars, common quality, M. 104 to M. 107; iron bars, M. 130 to M. 133; basic hoops, M. 127.50 to M. 130; common basic plates, M. 127 to M. 129; heavy plates, for boiler-making purposes, M. 132 to M. 134; sheets, M. 137 to M. 140; drawn iron or steel wire, M. 122.50 p.t.

Coal in Germany.

There has been more inquiry lately for house fuel, and the consumption in engine coal is strong, as before.

The Iron Market in Austria-Hungary.

In most departments the position is fairly satisfactory, there being a sufficient number of orders forthcoming to keep the works going with tolerable steadiness for some weeks to come. The coal trade in Austria-Hungary has remained steady.

Satisfactory Accounts from Belgium.

The iron and steel industry has shown an upward tendency. Pig iron, hitherto neglected, has been slowly improving, but there is also an increase in foreign competition, especially in Luxemburg forge pig; this, and the steadily rising make of pig iron—20,000 t. per month over this year—have prevented a general upward tendency. Present prices for crude iron are, on an average, 2f. p.t. higher than before, being 59f. to 60f. p.t. for forge pig, 67f. to 69f. p.t. for foundry pig, and 66.50f. to 68f. p.t. for basic. Finished iron is in very good request, both locally and on foreign account, and prices have shown a marked improvement. Brazil and Argentina, as well as India and Japan, are purchasing freely. Present quotations, f.o.b. Antwerp, for basic bars are £4 17s. to £4 19s.; the same in iron, £4 18s. to £4 19s.; rods, £5 6s. to £5 8s.; hoops, £6 1s. p.t. In hoops a particularly fierce competition has compelled makers to grant concessions of 1s. p.t. Exports for the first nine months show an improvement, although some articles, especially bars, were dull in the beginning of the year; total exports in bars, hoops, and other articles of finished iron were 375,470 t., as compared with 370,400 t. in the same period the year before, and 325,000 t. in 1909. To Great Britain 73,100 t. were exported, British India 55,340 t., Argentina 35,350 t., Turkey 20,600 t., Holland 20,200 t., Japan 15,500 t., China 14,750 t., and small quantities to some other countries. Imports, too, have increased by 31,500 t., as compared with 24,500 t. in 1910 and 24,400 t. in 1909. From Germany 25,000 t. were imported to Belgium last year. A particularly lively business was done in plates, and the increasing demand has caused prices to improve; compared with September of this year a rise of 4s. to 6s. is reported. Exports in the first nine months of this year rose to 117,600 t., as compared with 100,700 t. in 1910 and 96,750 t. in 1909, France, England, British India, Holland and Argentina being the chief customers. Present rates, free Antwerp, are:—Sheets, £6 10s. to £6 12s. p.t.; heavy basic plates, £6 1s. p.t. Inland rates also are firmly maintained; for plates of ¼in. 165f. to 170f. p.t. is quoted, for heavy basic plates 152f. to 157f. p.t. free Charleroi. Import in plates, chiefly from Germany, also showing improvement, 16,500 t. having been imported, as compared with 15,400 t. in 1910, and 13,850 t. in 1909; girder prices have advanced 2.50f. p.t. in consequence of a good demand and low stocks. After a period of general dulness rails have been quite brisk of late. Exports in girders to the end of September of this year were 55,200 t., as compared with 48,900 t. in the year before, and 39,950 t. in 1909; in rails, 121,800 t., as compared with 123,700 t. last year, and 75,800 t. in 1909. Holland bought 21,700 t., Brazil 21,500 t., Chile 15,100 t., and Argentina 11,000 t. Imports in pig iron to Belgium from January to the end of September were 488,800 t., as compared with 510,000 t. in 1910, and 350,000 t. in 1909; 296,700 t. came from Germany in 1911. Belgian exports in pig iron were very limited, amounting only to several thousand tons.

THE INSTITUTION OF WATER ENGINEERS.—The first (winter) general meeting of the newly incorporated Institution will be held at the Apartments of the Geological Society, Burlington House, W., on Friday and Saturday, the 8th and 9th of December, 1911. The proceedings will commence on Friday at 4 p.m., and on Saturday at 10.15 a.m. The following papers have been promised for reading and discussion, in addition to the other items on the programme, viz.:—(1) "Waterworks Management," by Messrs. Easton Devonshire and William Matthews. (2) "Portland Cement on Public Works, by Gerald Thornhill Edwards. (3) "The New Waterworks for Skegness," by Percy Griffith. Friday, December 8th: 4 p.m. The chair will be taken by the president, Mr. Edward Sandeman, M. Inst. C.E. Ballots will be taken for Council for the year 1912-13, and for new associate-members. A report on "Future Water Legislation and the Position of the Institution in regard thereto," prepared by the Water Areas and Statistics Committee, and approved by the Council, will be read, and, after discussion, submitted for adoption by the members. Reading of papers and discussions thereon. Saturday, December 9th: 10.30 a.m. The chair will be taken by the president. Reading of papers and discussions thereon.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

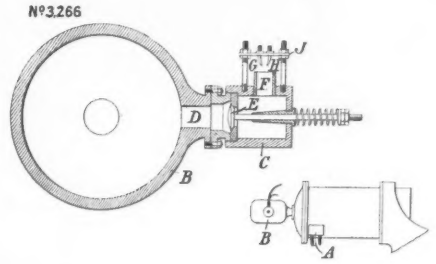
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of the Patent.

INTERNAL COMBUSTION ENGINES.

3266. February 8th, 1911.—IMPROVEMENTS IN INTERNAL COMBUSTION ENGINES, *E. L. Lecetus*, 55-56, *Basinghall-street, London.*

The engines referred to in this specification are of the self-ignition type, the improvements described relating to the mixing chamber. The air inlet and exhaust valves are of the usual type, and are situated at A. The combustion chamber is also of the ordinary pattern, and is shown at B. To the side of this combustion chamber a mixing chamber C is attached. The passage D between the combustion and mixing chambers is controlled by a

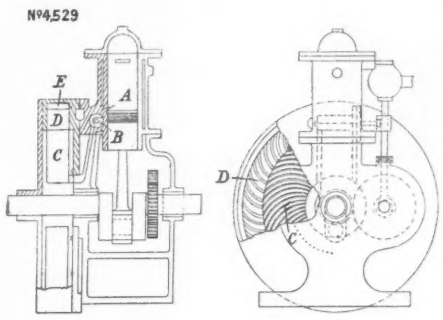


suction valve E. The mixing chamber is open at its top at F to the atmosphere. A short distance above this opening two nozzles, G, H, are fixed, which nozzles communicate respectively with a fuel supply pump and a water supply. The nozzles are carried by a cross bar J, which can be adjusted in height. An air space is thus left round the nozzles, so that they are not subjected to the full effect of the suction. It is stated that an engine provided with this mixing chamber is highly efficient and runs satisfactorily on crude and heavy oils.—*November 8th*, 1911.

TURBINE MACHINERY.

4529. February 23rd, 1911.—IMPROVEMENTS IN COMBINED RECIPROCATING ENGINES AND TURBINES, W. J. N. Brett, of 182, Balfour-road, Ilford, and W. J. Sneary, of 55, Compton-avenue, East Ham.

The feature of this invention is that the piston engine and the turbine are mounted on the same shaft in close proximity. The engraving shows the piston at the end of its stroke. The steam, or gas, is exhausting through the port A, past the valve B, and

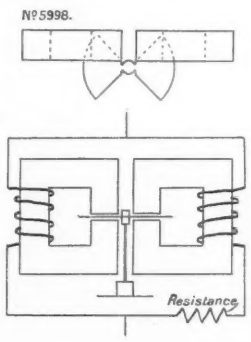


into the blades of the turbine C. Leaving these blades, the working fluid impinges against fixed blades D in the interior of the turbine casing. From these blades the fluid passes into the channel E and so to the final exhaust or to the condenser. It is claimed that the combination increases the power, assists in balancing the whole system, and enables a fly-wheel to be dispensed with.—*November 8th*, 1911.

TESTING AND MEASURING INSTRUMENTS.

5998. March 10th, 1911.—IMPROVEMENTS IN PERIODICITY INDICATORS, Lancelot William Wild, of York Mansion, York-street, Westminster, S.W.

If two magnets energised by alternating current are so disposed

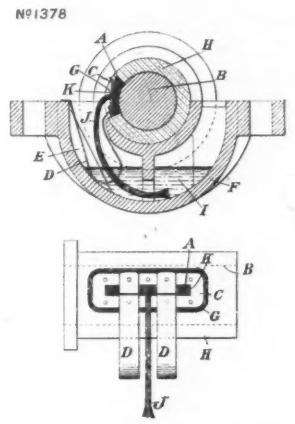


as to exert upon a suitably shaped vane of metal repelling forces in opposite directions the vane, if freely suspended, will take up such a position as will bring the two opposing forces into equilibrium. If the ratio of the two currents energising the two magnets respectively is varied then the opposing forces acting upon the vane will be thrown out of equilibrium, and the vane will rotate on its axis until it arrives at a new position in which the two opposing forces again become equalised. If one magnet is wound with many turns of copper wire, so that the ratio of inductance to resistance is large, the current energising this magnet will at constant voltage vary approximately inversely as the periodicity. If now the second magnet is wound with comparatively few turns of copper wire and is connected in series with a non-inductive resistance, the current energising this magnet will be nearly independent of periodicity. If now the two circuits energising the two magnets respectively are connected in parallel to the same source of supply the ratio of the currents energising the two magnets respectively will vary as some function of the periodicity; the ratio of the two opposing forces will also change with change of periodicity, and the vane will take up a fresh position with every change of periodicity. Any change of voltage will affect both circuits, and the position taken up by the vane will therefore be practically independent of the voltage. An instrument constructed on these lines is shown in the accompanying illustration. The magnet on the left is wound with many turns of copper wire, so as to obtain in this circuit a high ratio of inductance to resistance, whilst the magnet on the left is wound with one-tenth of the number of turns on the coil.—*November 8th*, 1911.

DYNAMOS AND MOTORS.

1378. January 19th, 1911.—IMPROVEMENTS RELATING TO THE LUBRICATION OF THE ARMATURE BEARINGS OF ELECTRIC MOTORS, Charles James Jewell, of The Hawthorns, Agbrigg-road, Sandal, Wakefield.

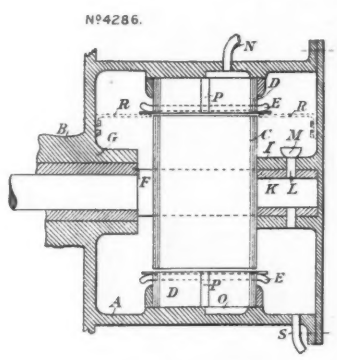
A pad A of wool presents to the armature shaft B a surface of an oil-retaining nature, the pad being attached to a metal frame C, to which are fastened springs D adapted to fit between webs E within the armature bearing cap F or within the motor frame or other convenient place. The spring frame thus holds the wool pad A in



position within the slot G of the bush H, maintaining contact between the pad and the shaft and ensuring a good supply of lubricating oil to the bearing, the oil being drawn from the well I through wool or other fibrous wicks J which are connected to the pad through a central slot K in the frame C. In some cases it may be found convenient to divide the pad and its supporting frame into two sections, each such section having a separate oil wick and having its own spring or springs.—*November 8th*, 1911.

4286. February 20th, 1911.—IMPROVEMENTS IN AND RELATING TO ELECTRIC MOTORS, William Richard Macdonald, engineer, of 60, Hallam-street, Portland-place, London, W.

This invention relates to electric motors which are intended to be worked submerged in water, and particularly to an improved construction of bearings for such motors. A represents the motor casing formed integral at B with the casing of the pump. C is the rotor of the motor—in this case a squirrel-cage rotor—and D is the stator of the motor fixed to the casing A. E shows the winding of this stator. F are the brasses of a bearing formed in a cylindrical extension G of the casing. An enclosing plate is fixed to the motor casing carrying the cylindrical extension I enclosing the bearing brasses K. This latter cylindrical extension

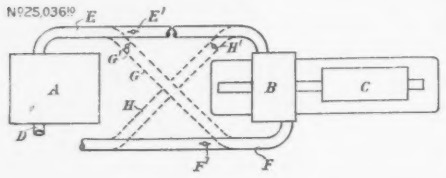


and brasses are perforated as seen at L, the cup M being fixed at the top of the perforation. N is an entry pipe for water into the annular circumferential recess O, to which the cooling water is supplied by the pump. P represents a number of radial ducts allowing the cooling water to pass into contact with the field winding E and on to the surface of the squirrel-cage rotor C. The water passes from this duct along the air space, and passes out at either end. In the usual way this rush of water would tend to damage the ends of the coils E. In order to obviate this, fixed baffle plates R are provided to deflect the water away from the field coils E. As shown, these plates are bolted to the ends plate, but they might equally well be formed integral with the rotor or with the stator. The lubricating water may readily pass into the cup M and perforation L to the bearing K, and afterwards is caused to pass out through the outlet pipe S.—*November 8th*, 1911.

25,036. April 28th, 1911, November 2nd, 1911.—IMPROVEMENTS IN AND RELATING TO THE COOLING OF DYNAMOS AND THE LIKE, George Henry Fawen, of the Altrincham Electric Supply, Limited, Chester.

A indicates a refrigerator, B is an electric generator, C is the turbine. The generator may have formed in its stator and rotor or either of them channels or conduits for the passage of air. The

air enters the refrigerator A through the pipe D and passes therethrough, being cooled to the desired extent, and passes in its cold condition through the pipe E to the generator B from which it emerges in its heated condition through the pipe F. The heated air emerging from the generator may be utilised. The air may be forced through the refrigerator A, the pipe E, the generator casing or channels, and the pipe F, by means of a fan which forces the air into the refrigerator through the pipe D, or it may be drawn through the same parts and pipes by means of a fan in connection with the pipe F. Instead of air, water may be similarly drawn or forced by a pump through the refrigerator A, the pipe E the

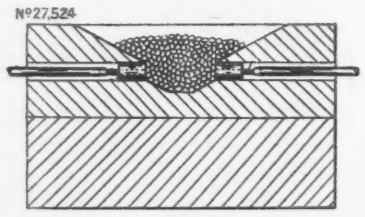


accessories of the generator B, and the pipe F. If the air or water for cooling the generator is constantly passed in association with it in one direction only, there is danger of some of the coils or parts getting dangerously hot whilst other parts are cool. To obtain equal cooling of all parts of the generator the direction of flow of the air or liquid may be reversed. This can be conveniently effected by means of the cross-over pipes G, H, shown in dotted lines, which connect together the pipes E and F, and by means of the valves E^1, F^1, G^1, H^1. An arrangement for automatically controlling the supply of cooling fluid is also described.—*November 8th*, 1911.

MACHINE TOOLS AND SHOP APPLIANCES.

27,524. November 26th, 1910.—SMITHS' HEARTHS OR THE LIKE, W. A. Bone, of the University, Leeds; J. W. Wilson, of Carlton Works, Armley, Leeds; and C. D. McCourt, of 13, Malwood-road, Balham Hill, London, S.W.

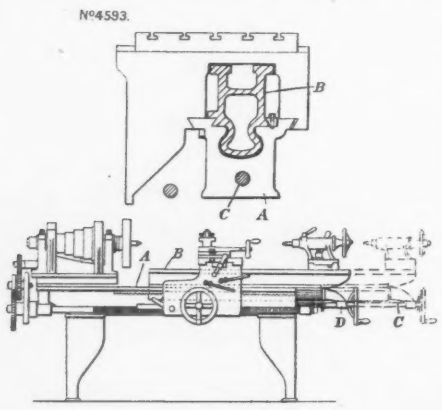
This is a smith's hearth worked on the "surface combustion" system, which we described in our issue of April 14th of this year. A mixture of any suitable gas and air is led to the bed of granular refractory material through two pipes, the speed of delivery being such as will prevent back ignition. The mixture burns in the bed raising the refractory material to incandescence, but without the



production of flame. It is stated that a suitable pressure for the gaseous mixture is 2 lb. per square inch. If low temperatures are desired, say for working copper or brass, producer gas may be used, while the refractory material may consist of crushed firebrick. For higher temperatures coal gas, coke-oven gas, water gas or other gas may be used in conjunction with a refractory material, such as very pure calcined magnesite. For low temperatures, the hearth may be built of ordinary firebrick, but for higher temperatures it should be lined with a highly aluminous firebrick or bauxite with a high degree of purity and free as far as possible from ferric oxide.—*November 8th*, 1911.

4593. February 23rd, 1911.—IMPROVEMENTS IN LATHES AND THE LIKE, Henry Bamford and George Sonnenthal, both of 85, Queen Victoria-street, London.

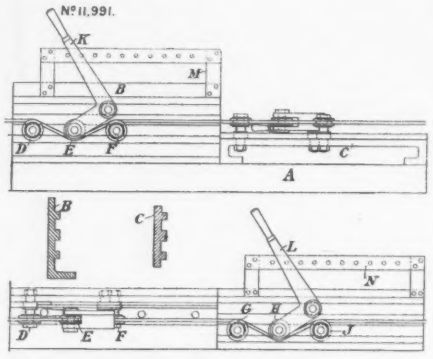
This lathe is of the extension bed pattern. The fixed bed is shown at A and the sliding bed at B. It will be seen from the cross section that to ensure rigidity the sliding bed is formed with a semi-oval projecting hollow rib on its under surface, and that this



rib fits closely within a correspondingly shaped recess in the fixed bed. The head-stock is carried on the fixed bed and the tail-stock is mounted adjustably on the sliding bed. The sliding bed is moved by a screwed shaft C passing through a bracket D on the sliding bed and a fixed nut on the fixed bed. A clamping device is provided. The saddle slides on the fixed bed, and is arranged to bridge over the sliding bed.—*November 8th*, 1911.

11,991. May 18th, 1911.—IMPROVEMENTS IN THE MECHANICAL REMOVAL OF MILL SCALE FROM ROLLED METAL RODS OR BARS, L. D. Whitehead, of Deighton Iron and Steel Works, Tredegar, Monmouth.

To remove the scale from metal bars preparatory to their being cold drawn they are bent first in one, then in the other direction, so that the scale is broken up and caused to fall off. The machine for effecting this bending consists of a bed-plate A, to which members B C carrying the bending appliances proper are attached. These appliances consist of rollers D E F and G H J. The rollers D F and G J are mounted respectively on the members B C, but the rollers E H are carried on bell-crank levers K L pivoted to the members B C. The position of the bell-crank levers is regulated by pins passed through holes in the frames M N. The bar to be scaled is pulled through the rollers, the bending to which it is

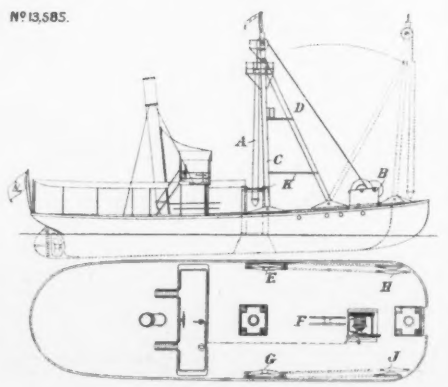


subjected being regulated in amount by the position of the bell-crank levers. It will be seen that the first plane of bending is at right angles to the second.—*November 8th*, 1911.

SHIPS AND BOATS.

13,585. June 7th, 1911.—IMPROVEMENTS IN NAVIGABLE ROCK CUTTERS, Fred Lobnitz, of Ross Hall, Crookston, Renfrewshire, Scotland.

The vessel is made with a central well and a well at the bow, so that the rock cutter can be worked either from the midships or bow position. The rock cutter is shown at A, and the winch for operating it at B. The rock cutter is suspended from a guide



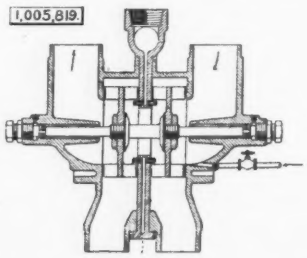
pulley mounted on top of a tripod, the legs of which are shown at C and D. The central leg is joined by a pivot to the top of the two others. The lower ends of all three legs are secured to shoes E F G fixed to the deck. Two additional shoes H J are fixed forward for taking the two outside legs when the cutter has to be worked from the bow. Guide rails may be laid between the shoes E and H and G and J. When in either position the legs are bound together by girders K.—*November 8th*, 1911.

SELECTED AMERICAN PATENTS.

(From the United States Patent-office Official Gazette.)

1,005,819. GAS CLEANING APPARATUS, *O. H. Ensign, Madison, Wis.—Filed May 22nd*, 1908.

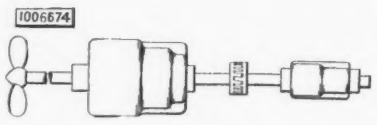
This patent is for passing the gas through a sheet of spray. The invention consists in the combination of a casing comprising two or more compartments, rotatable mechanism between the compart-



ments, and means for projecting liquid against the rotatable mechanism to form a partition of spray completely separating the compartments from each other. There are no fewer than twenty-four claims.

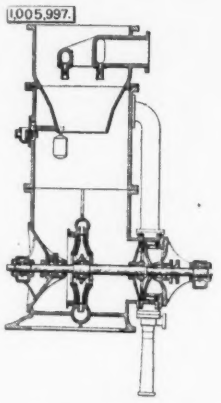
1,006,674. MARINE PROPUSION, *C. A. Parsons, Newcastle-on-Tyne, and S. S. Cook, Wallsend, England; said Cook assignor to said Parsons.—Filed July 17th*, 1911.

The invention consists in the combination in a marine turbine



installation, of means connecting two portions of a shaft, said means producing a thrust which is proportional to the torque transmitted between the shaft portions and which acts to balance the propeller thrust. There are ten claims.

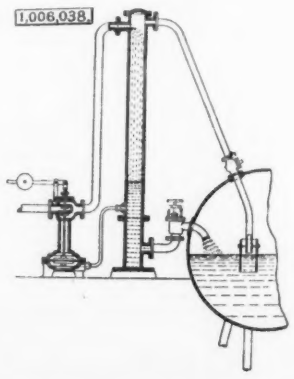
1,005,997. CONDENSING APPARATUS, *T. Mohn, Manchester, England, assignor, by mesne assignments, to the Colonial Trust Company, trustee, Pittsburgh, Pa., a Corporation of Pennsylvania.—Filed September 29th*, 1909.



As will be seen, this invention consists in the use of centrifugal water circulating and air pumps mounted on the same shaft. There are two claims.

1,006,038. FEED REGULATOR FOR BOILERS AND THE LIKE, *J. Wyllie, Blundellsands, near Liverpool, England.—Filed March 1st*, 1909.

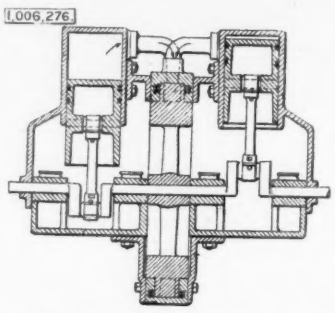
A stand pipe is provided into which the feed water is pumped through a valve, the position of which is controlled by a valve



actuated by a flexible diaphragm, as shown. This has the stand pipe in communication with one side, the boiler with the other. The admission of feed depends on the height of the water in the stand pipe. There are nine long claims.

1,006,276. COMBINED COMPOUND CRANK AND ROTARY ENGINE, *G. C. Richards, Berkeley, Cal.—Filed November 15th*, 1910.

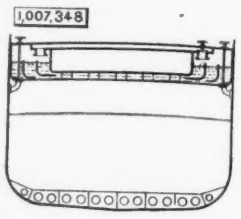
This invention consists in the combination in an engine of a crank shaft, a series of internal combustion engines connected to the shaft, a casing having bearings supporting the shaft, a rotor



between the engines on the shaft, a ring in the casing circumferentially enclosing the rotor and having jet openings whereby exhaust gas from the engines may be projected against the rotor, and yieldable packing devices interposed between the ring and the faces of the rotor to prevent leakage. In other words, to direct engine exhaust into a central turbine. There are two claims.

1,007,348. MEANS FOR DAMPING THE ROLLING MOTION OF SHIPS, *H. Frahm, Hamburg, Germany.—Filed July 6th*, 1911.

This patent is for an improvement on the well-known cross tank system, which was brought into prominence some years ago by Professor Biles. A U-shaped water chamber is arranged athwart ship comprising side tanks connected together by a water conduit, the water chamber being adapted to damp the rolling motions of



the ship; means are provided for preventing impacts and disturbance of the water in the water chamber during the rolling motion of the ship and for effecting a uniform rise of the water in the side tanks, comprising bent guide plates adapted to divide the water flowing from the water conduit into the side tanks into a plurality of streams and direct the water upwardly in the side tanks. There are four claims.

SOME IMPRESSIONS OF CONTINENTAL MARINE DIESEL ENGINE PRACTICE.

No. I.

IF an invention or novelty is brought before the marine superintending engineer, or, indeed, we may almost say any engineer of the present day, probably the first question he will ask is, "What will it save me?" A device or arrangement may have merit in other directions in addition or instead, which appeals irresistibly for adoption to meet certain conditions, but there is no doubt that in the long run it is only the invention which will be able to show a real saving either in first or in running cost that can hope really to go or to have any chance of universal or even of general adoption; at the same time, we are not prepared to say that the converse holds good, and that any device which shows a saving is bound to secure universal application even with the qualification *ceteris paribus*. When in any particular case under consideration the savings are claimed to embrace not only money, but time, weight, and space—which, after all, generally refine out into the same thing—then the subject in question undoubtedly demands the most serious consideration of all who could in any way possibly be concerned. It is on account of these claims that we have of late been giving such very careful attention to the question of the employment of oil engines for marine propulsion and particularly of the type associated with Dr. Diesel's name. Diesel engines for stationary purposes have been built on the Continent for years now, and yet there were only two firms in this country who had had any experience of their construction until their application to marine engines, which almost immediately led our builders to tackle the question seriously, and now very many of the leading marine engine builders in this country are taking or have taken out licences from one or other of the continental builders. This licensing, by the way, means that the licensee is supplied with all the necessary drawings, and such assistance in the way of practical experience as can be passed on, though how far the value of this passing on of experience falls short of the actual experience itself in this difficult question of the building of this type of engine only those know who have tried. The difficulties in connection with the allowance for expansion and warping in the cylinders, for example, are undoubtedly immense, and experience itself is the only sure guide. We put this point forward with some insistence as a stimulus to those firms who have not yet gone into the question in order that they may be induced to set to work at once to make up for lost time, and we trust that the notes which follow may be of some assistance in their investigations. At the same time, we must state that we do not claim that we are able to present a complete report of all that is being done on the Continent or even at the works to which we shall refer, as in some instances we were courteously given much information under a pledge of secrecy, while in other cases we were perfectly well aware that work was being executed of which we were not favoured with particulars. Of such work we prefer, to say nothing, but there will still be found enough to provide a considerable amount of food for thought. It may not be out of place to remind our readers that, in addition to the five works mentioned in these notes as builders of Diesel engines, there are also the firms of Krupps, Blohm and Voss, Augsberg, Burmeister and Wain, and others, together with Normand, Sabathé, Fiat, and the Nederlandsche Fabriek, whose productions we have already described, while in this country Messrs. Barclay, Curle and Co., J. S. White and Co., Furness, Westgarth and Co., Thornycrofts, and Vickers have work in hand not sufficiently far advanced to be dealt with, whilst Alex. Stephens and Son, Yarrow, Harland and Wolff, Fairfield, the Clyde Shipbuilding Company, and others are, shall we say, on the verge.

The Diesel engines which we have already dealt with in our descriptive articles have all been of the four-cycle type, while those which we are now about to describe are mostly of the two-cycle type, and we hope that we may be excused if we follow the cycle of operations for the benefit of those who are not yet acquainted with the two-stroke scavenging cycle. We will be as brief as possible, and the remainder of the paragraph can be skipped by those who are already *au fait* with the subject. The arrangement of the exhaust ports is exactly the same as with an ordinary small two-cycle engine, except that they occupy the greater part of the circumference of the cylinder in order to obtain sufficient area, and lead into a water-jacketed belt connected to the atmosphere. But closely following on the opening of the exhaust ports, a special scavenging air inlet valve in the cylinder head is opened mechanically, admitting air compressed in the scavenging pump to a pressure varying from 4 lb. to 7 lb., which effectually prevents any laziness on the part of the exhaust gases, and thoroughly scavenges the cylinder of all residue, leaving only pure air to be compressed on the return stroke of the piston. Just before the top of the stroke the fuel valve opens, oil is injected, and combustion takes place on the ordinary Diesel principle. Thus it will be seen that the Diesel two-cycle engine dispenses entirely with crank case compression, whether of mixture or of air only, which leaves much greater freedom in design, besides doing away with a fruitful source of trouble. It will also be realised that, as with some few other designs of two-cycle engine, there can be no loss of unburnt charge through the exhaust ports, a loss which as has been shown by Dr. Watson may amount to as much as 35 per cent. under certain conditions,

The description of what we saw at the works of Messrs. Carel Frères at Ghent amounts, if we may so put it, to an account of what is not being done; but in spite of this we think that the illustration which we are able to give in Fig. 1 is of great interest—not, indeed, as an illustration of the present-day practice of the firm, but as some indication of what Messrs. Carel Frères have already done, and the position to which they have attained in the twelve years during which they have been at work on the Diesel engine, a position which has enabled them not only to construct some of the largest vertical type Diesel cylinders known, and to grant licences to some of the biggest engine-building firms in this and other countries, but also to claim that their Diesel engines are the cheapest on the market. The engraving in question—Fig. 1—represents a four-cylinder two-cycle marine reversible engine with cylinders 450 mm. diameter, 560 mm. stroke, designed to give 1000 brake horse-power at about 250 revolutions per minute, and weighing about 78 lb. per horse-power complete. In connection with it the general use of steel castings for bed-plate and cylinders (jackets not liners) should be noted. This constitutes the highest powered marine engine which we have yet described in detail, and yet our impression was that it is very appreciably smaller than the six-cylinder 500 horse-power engine of the Vulcanus. This, however, would, of course, be fully accounted for by the fact that the latter works on the four-cycle, and has piston rods and cross-head guides as compared with the trunk piston of the two-cycle, with its 50 per cent. higher speed of revolution and the two working strokes to one. That is to say, that a considerable difference was of course to be anticipated, but we should not have anticipated that it would be so great. Criticism of the engine in question is entirely disarmed by the fact that the whole design has been completely altered in the latest models, drawings of which we were courteously permitted to examine. When the time is ripe for publication these will be found to embrace among other things the short piston with cross-head and flat guides, an open engine, and a general close resemblance to the marine steam engine of to-day. We can, however, simply describe the engine as we saw it.

Fig. 1 shows the general arrangement with four vertical single-acting cylinders, valves in the cover as usual, and scavenging pump at the forward end of the crank shaft. The high-pressure air is provided by a Reavell rotary three-stage compressor, of a form with which our readers are acquainted. Lubrication to the crank, connecting-rods, &c., is forced and they all are in consequence enclosed; forced lubrication does not, however, extend to the cam shaft, which is not enclosed, and the builders make rather a point of this in this particular engine as being all they can do on the lines of what the marine engineer is used to in having everything exposed to view. The scavenging valves, of which there are four per cylinder, the fuel admission valves, and the compressed air starting valves follow what is now apparently standard practice, with one exception, by being placed in the cast steel cover; the rockers of the latter two are pivoted in the manner now usual, so that one movement places one in action while it places the other out of action. Unlike the Vulcanus engine, but again following what is apparently universally accepted practice, the overhead cam shaft is driven through a vertical shaft by skew gearing off the crank shaft, the gears being enclosed in an oil-tight case, which, with the carefully cut gears which can now be obtained, seem to give perfectly satisfactory results.

It will be noticed that the vertical shaft is not continuous, the object of which will be given in dealing with the method of reversing, which, as with most of the two-cycle engines, is a very simple operation; we were informed, in fact, that with this engine driving a full load through a belt the operation can be performed in 14 sec. from full ahead to full astern, which speaks volumes for the belt as well as for the reversing arrangements The motions necessary comprise only one movement with each of two small levers and a hand wheel—a great simplification on any of the four-cycle engines which we have yet dealt with, as is only to be expected, seeing that there is no idle stroke or exhaust valve to provide for. To start up it is only necessary to put the reversing lever—a very small lever which can just be made out on the left of the big hand wheel—into the ahead position, pull the throttle lever open, and turn the hand wheel one quarter of a turn to put the compressed air starting valves into operation and the fuel valves out—this latter is controlled by a cam on the hand wheel spindle; another quarter turn puts two cylinders on oil, while the other two are "towed," and another quarter turn puts all four cylinders on oil and the motions are complete. This second position, with two cylinders "towed," provides for a very slow speed of revolution if required for manœuvring. Though we have described three separate quarter turns of the hand wheel, the motions are practically continuous and may fairly be described as a single movement.

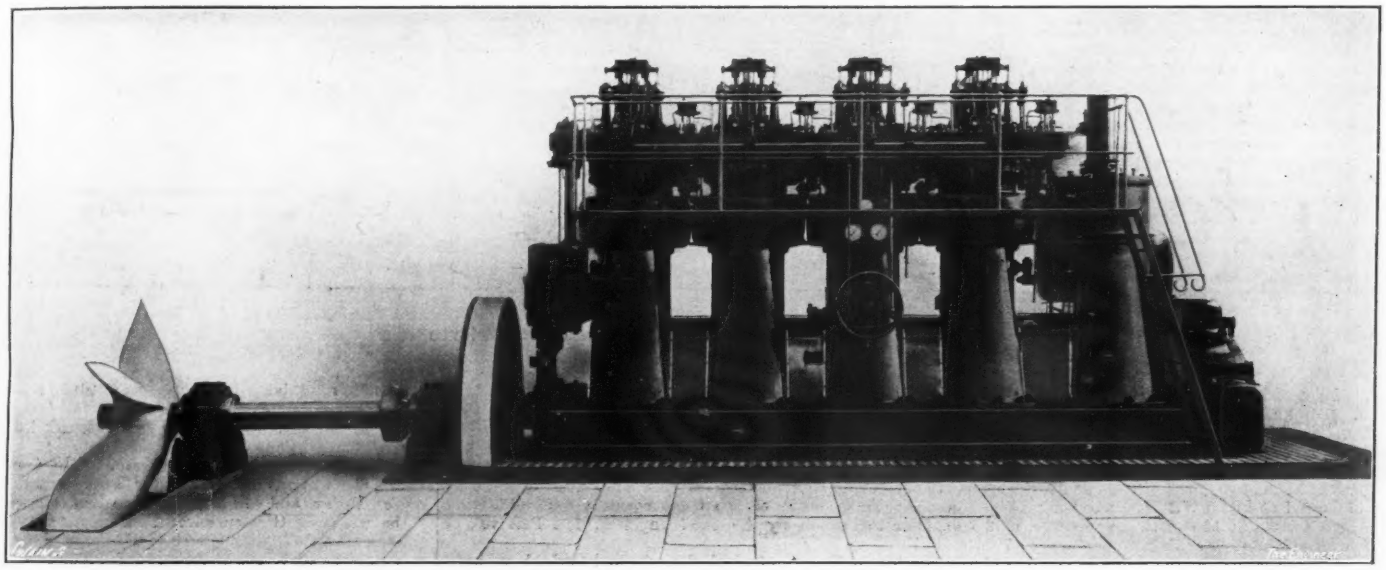


Fig. 1—1000 BRAKE HORSE-POWER TWO-CYCLE MARINE OIL ENGINE—CARELS FRÈRES

The control of the speed of the engine when once started is, as usual, obtained by varying the delivery of the fuel pumps, of which there is, of course, one to each cylinder. The movement of the reversing lever to either position admits air to a servo motor contained in the case shown in the middle of the vertical cam shaft driving spindle, which alters the angular relationship of the two parts of the shaft to each other, and thus the angular relationship of the cam shaft to the crank shaft, which reverses the small amount of "lead" of the valves from one side of the centre line to the other, as indicated in the diagrams to be given later, and described in detail in connection with the M.A.N. engines, and so sets the valves for rotation of the engine in the opposite direction. When the engine is started on air, this lever is automatically returned to the vertical position, and is then so interlocked with the hand wheel that it can only be moved when the hand wheel is in the stop position, so that the engineer is automatically prevented from damaging the engine by making a wrong movement of his levers. It will be understood, then, that to stop the engine only the hand wheel has to be operated, and when moved into the stop position everything is in readiness for either ahead or astern gear.

In this design of engine access to the piston is a somewhat troublesome job, and means the removal of the cover and a good deal of gear; but, as we say, it is not fair to criticise, in view of the new designs which will be adopted in future. There is also under construction a six-cylinder two-cycle engine of 1800 brake

horse-power for a German firm, among others, and we were given some particulars of a single-cylinder, single-acting reversible engine, with cylinders 32 5/16 in. diameter by 38⅛ in. stroke, constructed for Messrs. Schneider and Co., of Le Creusot, for experimental purposes which will be referred to later. We were much interested to note the large use which is being made of steel castings throughout the engines, some being of the most complicated form and wonderfully clean. The Reavell air compressor used for producing the high-pressure air consists of a pair of opposite cylinders for the first stage, the plungers of which are driven off a pin on the crank shaft; air is drawn in through a valve formed in the gudgeon pin and driven through a cooler into the first receiver; from there it is drawn into the second stage compressor, which is vertical and below and opposed to the final high-pressure compressor, the gudgeon pin again forming the suction valve, the delivery valves being of the ordinary clack valve type. All four cylinders are contained in a case filled with water, so that the cooling is most efficient and the whole arrangement is compact and being an independent unit is easily fitted in place.

THE LÖTSCHBERG-SIMPLON RAILWAY AND ITS CONSTRUCTION.

No. III.*

PROCEEDING southwards from Fürthen to Kandersteg along the construction railway, the following important substructures are to be noted on the latter:—At kilom. 5.8 and at 882 m. altitude there is, first, the siding of Fürthen, which is followed by a trestle bridge with four openings of 7 m. span and two openings of 3.5 m., and then a tunnel of 26 m. long through a cliff at kilom. 6.8 below the Felsenburg Tower—see Fig. 3, page 531. A steel structure then crosses the diligence road at kilom. 7.14 in two spans of 11 m., two spans of 7 m., and three spans of 3.5 m., followed at kilom. 7.2 by a wooden viaduct over the Stegen torrent in 14 panels, or openings, of 3.5 m., and then by yet another with six openings of 7 m. and one of 3.5 m., succeeded by the siding at kilom. 8 74 at an altitude of 1019 m., which is shown on the west side of the spiral curve of Mittholz in Fig. 3.

From this point southwards commences a serpentine course of the construction line for the artificial development of its length, in order to reduce the gradient to 1 in 16 on the sharp rise of about 118 m. which intervenes up to Aegerten in a distance of under 1 kilom. At kilom. 9—see Fig. 3—there is a steel bridge in four spans of 5.4 m. of 21.6 m. total length carried on masonry piers, the S-loop, which then succeeds, being the great trestle viaduct of Schlossweide, with 23 panels each 7 m. in length and a height at its deepest portions of about 50ft., where the structure is built in four stages. The line now heads towards the river, and crosses the high road—see Fig. 3—on another viaduct in two openings of 7 m., one opening of 9 m., and nine openings of 3.5 m.

At the tenth kilometre—see Fig. 4—the Kander River and valley is crossed by a series of three steel bridges of respective lengths of 9.3 m., 7.9 m., and 6.4 m., the line then making a remarkable detour altogether away from the main line railway, in order to climb up around the Aegerten dell, and then, after proceeding 1 kilom., to arrive back again at the riverside only 250 m. in advance of the point where it had crossed.

Following this loop, of which one part is on a curve of 50 m. radius, and almost describes a complete circle, there is a series of viaducts, one of eight openings 7 m. long, another of the same length, and one with four panels of 7 m. These huge wooden structures are built in four stages, with a total height of about 20 m., or 66ft., from the ground at the deepest parts, and the rails are laid on a gradient of 57 per 1000, or rather less than 1 in 18. Seen from below, with a heavy construction train ascending around the curve of 50 m. radius, these timber piles appear hardy in conception; but they are solidly built, and on the curves there is considerable stagger to the buttress posts. The vertical posts are tied together by traverses and diagonals, the latter being in the form of St. Andrew's cross, as are also the strut frames which brace the top stage in the longitudinal direction. Over the top longitudinal beams of the trestles are laid the sleepers, which, in turn, carry stringer beams, to which the rails are bolted. The longitudinal beams are therefore double. Foot planks and hand rails are provided on one side of the viaducts. Below, there are well-built masonry piers, sometimes partly of concrete, with foundations accurately laid to depths of up to 1 m. below the surface of the ground. The permanent way is well laid and aligned and ballasted, the curves being limited to 10 m. radius. The excellence of the line may be to some extent judged by the fact that on the crowded morning train of open narrow platform cars, the chief engineer, assistants, and workmen, all standing erect for want of space, keep to their feet without anything to hang on to. These timber viaducts traverse a beautifully wooded region, and it must be said that their semi-rustic construction detracts in no way from the picturesque surroundings.

With a final steel bridge of 5.4 m. span the difficult curves of Aegerten are terminated, and the construction line then keeps along the west bank of the Kander, through Kandersteg. It crosses the Kander just beyond, at the 13th kilometre, on a steel bridge with a length of 14 m., running alongside the main line, and, shortly after traversing the road leading towards the Gemmi Pass on steel girders of 5.4 m. span, it immediately enters the Lötschberg Tunnel works, past which the line continues 200 m. into the tunnel.

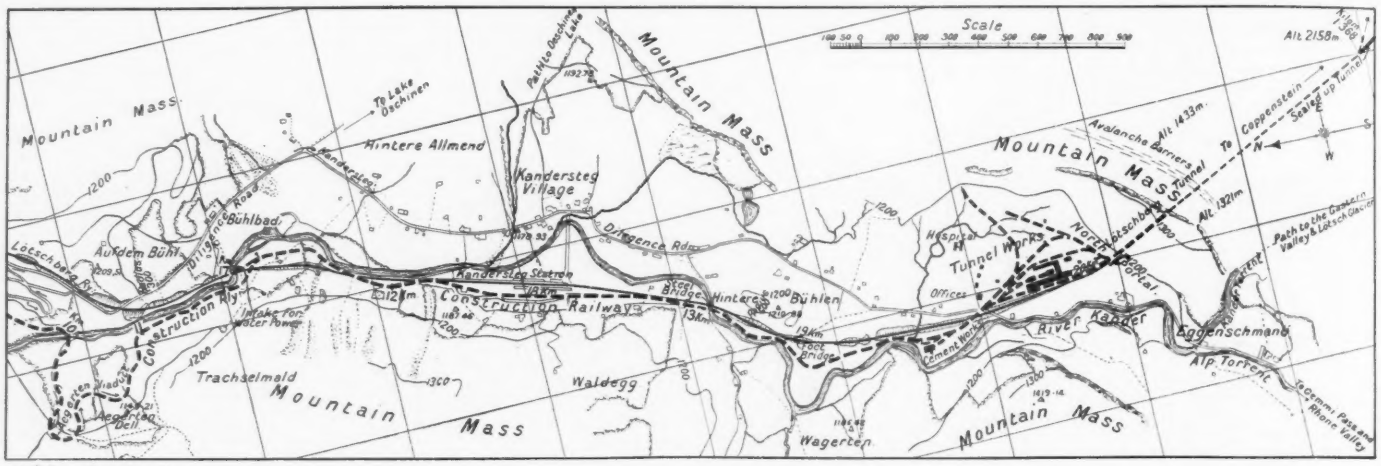
On the construction railway the traction is effected by two powerful eight-coupled tank locomotives, with outside frames and coupling rods, 3.9 m. between extreme axle centres, 5.5 m. total length, and weighing 25 tons. The trains are usually made up of some four or five platform or box cars, occasionally a passenger car and a couple of trucks for rails or timber, making in all a weight of about 30 tons exclusive of the engine. The time occupied in reaching Kandersteg was formerly about 50 or 55 minutes, but recently the requirements have not rendered necessary a regular service up to that point. In concluding the mention of this line, acknowledgment should be made of the frank courtesy evinced during our inspection by the chief engineer, Mr. Pettavel, of Frutigen.

The main line, of which the principal works have been summarised on page 532, has four stations beyond Frutigen. These are:—Kandergrund, at kilom. 4; Blausee-Mittholz, at kilom. 8.94; Felsenburg Halt, on the ledge of the cliff, at kilom. 13.690. just above the Felsenburg Tower—see Fig. 3—and, finally, Kandersteg, at kilom. 18.120.

The sylvan station of Mittholz will provide the nearest rail access to the wonderful lake of sapphire-blue known as the Blausee—see Fig. 3—which originates from underground springs, and maintains a nearly equable temperature, never falling, even in the severest Alpine winters, to below freezing point, the average being + 6 C. = 42.8 Fah. A further attraction of the new route will be the fine scenery on the line between Felsenburg and the helical tunnel. Frutigen station is arranged with sidings for the splitting up or doubling of ascending southward bound trains into small units and of making up heavy single units for the descent northwards to Spiez. Kandersteg has a shunting siding for the coupling together of small units arriving from Frutigen. In the summer season the tourist traffic will be attended with a break of journey at Kandersteg, which is an Alpine touring centre. The estimated speed for passenger trains of 140 tons weight up gradients of from 15 to 27 per thousand is 50 kilom., or 31 miles per hour, and for goods trains of 240 tons on the same inclines, 32 kilom. (20 miles) per hour.

For the entire work of constructing the Lötschberg Railway, and for its ultimate operation, the motive force is electricity produced by water power. Not a single stationary steam engine is in use at the tunnel works. A new hydraulic plant for traction purposes is being laid down with nearly a vertical pipe line on the precipitous western side of the Kander valley, just below Blausee. This, it is understood, will eventually be supplemented with a steam plant in reserve in case of the water becoming scarce at certain seasons of the year. On the northern side of the tunnel the electrical current is purchased from the Canton of Berne Power Supply Concession, which has the water-power rights of the Kander River, the highest intake being at Maeren at the level of the 17th kilom. on the Lötschberg Railway—see Fig. 4. The capacity of the forebay is 3½ million gallons, and the maximum altitude of the water is 1167 m. The penstock pipe is carried along the west side of the valley to Kandergrund, just above Frutigen. There is a fall of 300 m. to the Pelton wheels, which generate 8000 horse-power at 300 revolutions when supplied with 2.6 cubic metres of water per second.

On the other side of the mountain, in the Canton of Valais, the water is drawn from the Lonza torrent in the Lötsch Valley, and will be referred to in the description of the works at Goppenstein. The estimated power requirements for the whole work of the main tunnel were as follows:—1907, 400 horse-power; 1908, 1000 horse-power; 1909, 1500 horse-power; 1910, 2500 horse-power; 1911, 2500 horse-power.



"THE ENGINEER"

Fig. 4—THE LINE IN THE NEIGHBOURHOOD OF KANDERSTEG

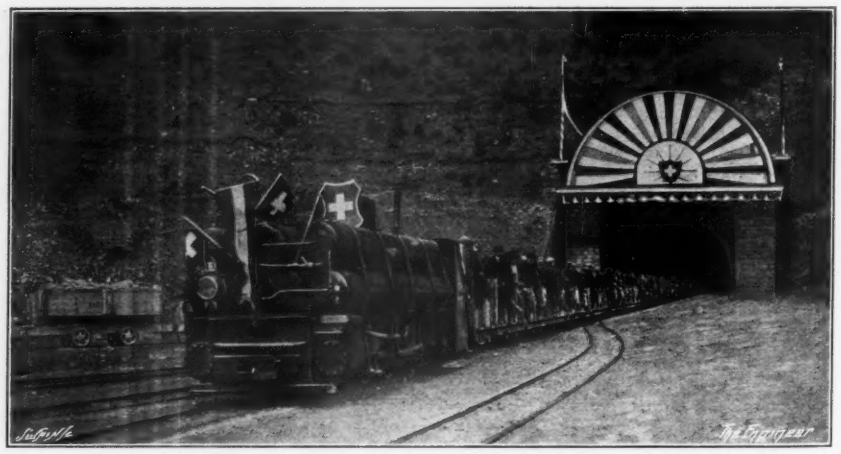


Fig. 5—AIR LOCOMOTIVE AT KANDERSTEG ENTRANCE TO TUNNEL

The arrangement for the supply of power appears to have worked with satisfaction to both the contracting parties, the suppliers being interested to provide for all the requirements of [the railway contractors, in view of the future utilisation of the plants for the traction of the regular trains, while the contractors themselves could not have generated power, by means of installations laid by themselves, for as low a price for current delivered as is actually charged.

At the Kandersteg tunnel works the electrical current is received at 15,000 volts, and stepped down by three

* No. II. appeared November 24th.

triphase transformers to 500 volts, with a frequency of 40. The transformers are oil insulated and water cooled, and each is of 500 kilowatts capacity. For running the air compressing pumps for charging the reservoirs of the compressed air locomotives there are two three-phase 10-pole motors working at 500 volts and 40 periods and each developing 400 horse-power; while three three-phase 10-pole motors, working at 500 volts, 40 periods, and each being of 250 horse-power, drive the air compressors for the compressed air services of the tunnel. In the machine tool shops there are other motors of 25 to 50 horse-power.

At this, the north, end of the tunnel the Meyer system of compressed air drilling plant is employed by the Swiss engineers, while at the south end the French engineers have preferred the Ingersoll. At Kandersteg, therefore, the air compressors are by Meyer, of Mulheim, two being of 400 horse-power for the compressed air locomotives, and three of 250 horse-power for the rock drills. The air compressors, which work at 120 revolutions per minute, are of the two-cylinder duplex type, and they charge the main reservoirs for supplying air to the locomotive reservoirs with 0.3 cubic metres of air per second at a pressure of 120 atmospheres.

The low-pressure compressed-air plant for the drills compresses 1 cubic metre of air per second to a pressure of 10 atmospheres when working at 110 revolutions per minute.

In the compressed-air storing rooms, the first, for locomotives, has two batteries of horizontal reservoirs, disposed in rows twelve high and twelve wide. These are for a pressure of 120 atmospheres, and have a capacity of 36 cubic metres, or 12 cubic metres in excess of the calculated minimum requirement, *i.e.*, 24 cubic metres. Some of the reservoirs are of French construction, while others are of the Meyer type. In another room are the compressed air reservoirs for the rock drills. From these the compressed air main proceeds direct to the tunnel. This main has an internal diameter of 169 mm.—just over 6½in.—and it is encased in another pipe, so that there is a clearance between the two of 5 cm., which space is filled up with scoriæ. From the high-pressure compressed air reservoirs the air is conveyed to the locomotives outside through a pipe of 60 mm. bore.

The compressed air locomotives used at the north end were made by Thébault, of Marly, France, and are five in number. Two large engines with eight coupled wheels and seven cylindrical reservoirs of 7.5 cubic metres total capacity are employed for work outside the tunnel. The next smaller size, of which there are two, are used for the masonry sections of the tunnel. One of these is seen in the view Fig. 5, which was taken on the occasion of the perforation of the tunnel. These have six-coupled wheels, while the one smallest tractor, which is used for the dressed sections of the advance heading, has four-coupled wheels and a battery capacity of 3 cubic metres. Between the pull on the draw-hook of the tractor and the power generated by the Pelton wheel there are, of course, two intermediary forms of power transmission, electric and compressed air, so that only a portion of each horse-power developed at the turbine shaft is effective at the train head; but for the rough work of the tunnel the recourse to the medium of compressed air, instead of using electric tractors, was unavoidable in view of the various risks attendant on the latter in confined spaces.

For the heavy work of the finished tunnel and the tunnel works ordinary locomotives are used; and these are the only examples of the use of the steam engine in the Lötschberg enterprise, all other forms of power being derived entirely from the fall of water—for the first time in the history of any great tunnel construction. Five locomotives are in use, four of which were made by Borsig, of Tegel, near Berlin, three of them having six coupled wheels and being of 100 horse-power, and one having four-coupled wheels and being of 50 horse-power. All are of neat design for contractors' engines, and work at 10 kilos. pressure. The fifth engine is Swiss-built, and, although not new, is interesting by reason of its having a wide type fire-box with two fire doors, and because its appearance is similar to that of a main line locomotive built to a small scale. The steam pressure is 12 kilos. per square centimetre, and the rating 80 horse-power.

Besides these, the only other form of traction employed in the tunnel has been horses, for which stabling accommodation for twenty-four was provided originally. Eventually this number was reduced to two or three for hauling the spoil cars in the restricted space in the advance heading.

The principal machine shops at the works were fitted with all necessary tools for the urgent repairs of locomotives and cars, drilling machines, &c., while an important smithy is always busy with the forging of and repairs to drilling bars. For the timber used for props, posts, and beams and car repairs there is a saw mill and wood-working shop. The pumping plant, now inactive, includes high-lift five-stage Sulzer pumps and low-pressure pumps, and the lighting plant of the works includes transformers which reduce the voltage from 500 to 125. Electricity is kept out of the tunnel as far as possible, the universal system of lighting in the tunnel being acetylene. This is stated to be the most practical of all illuminants, despite its obvious inconveniences where fresh air is of such vital consequence. In the shops themselves perhaps the most interesting process is the power forging of the "crowns" on the hollow drilling shafts, the shaping of the fangs from a primitive + cut into their ends involving a number of operations in the hands of the highly-skilled smiths, besides the tempering and final testing by striking on granite or gneiss.

Apart from the works is a concrete and cement works, with a jaw stone crusher by Beugot, of Maçon, and two crushing cylinders with a continuous automatic return to the mill of all material too large to pass the screens. In the stores near by is stocked a considerable quantity of Portland cement, sand, and gravel. Although there are no fixed steam engines, there is a certain stock of coal on hand, but this is for the baths and laundry, in which the steam boilers are worked up to 100 lb. per square inch. The baths comprise four baths in cubicles and 150 sprays or shower baths. Only a certain proportion of the miners use the baths, which are recommended but not obligatory. The tall clothes-drying lofts are fitted with 1200 lifting racks. To screen the miners coming from the hot tunnel from the sudden exposure to the intense cold of the Alpine winter when the gang train left the tunnel, the line from the portal to the baths was covered in, but this shedding has now been removed.

Removed some distance from the works is a large, well-fitted hospital, with accident and fever wards, although the latter have never been used. A peculiarity noted during a visit last summer was the preventive treatment which is permitted. In the case of some well-dressed miners lying on the beds we were informed that, being merely fatigued, they were resting there under medical supervision. On the grounds is a school for the children of miners and employés. Workmen's dwellings are provided near the Kander River. The ground taken in by the area of the works and out-building covers 16 hectares, or about two and a-half times more than that for the corresponding installations at Goppenstein. The general characteristics of the works at either end of the tunnel are widely different. At Kandersteg there is admirable order and brightness, which is in keeping with the surroundings. The nationality of the workers at both ends of the tunnel is the same, and the installations are the same, yet there is a distinct difference visible, giving a strong impression that one end is Teutonic and the other Latin. In all there are thirty buildings at the north portal, which cover an area of 8350 square metres, while the narrow-gauge railways of 75 cm. gauge laid out upon the grounds aggregate 8¼ kiloms. length, inclusive of seventy sidings. There is a turntable of 5 m. diameter. The rolling stock employed consists of some 350 spoil and masonry cars, 16 gang cars, and 20 platform cars.

On approaching the tunnel portal the attention is at once attracted by the immense protective works on the Fisi Schaafberg, right above the whole neighbourhood

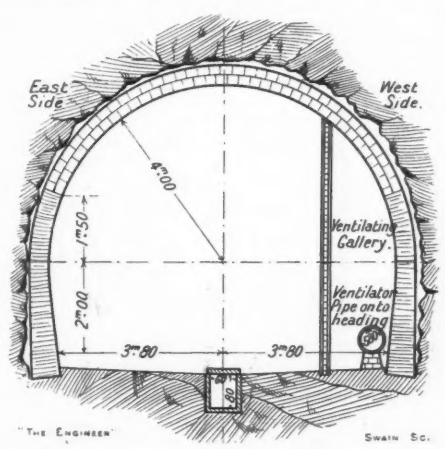


Fig. 6—TEMPORARY VENTILATING GALLERY IN TUNNEL

of the tunnel entrance. Seen from the distance, down at Kandersteg, these appear as huge masonry walls in series one behind the other like great battlements to baffle the falls of the snow, which would otherwise descend in avalanches direct on the line 120 m. below. These para-avalanches, as they are called, must have involved in expenditure a large proportion of the total cost of the line.

The portal of the tunnel is built with a connection to an adjoining ventilator house, in which are two centrifugal fans made on the Capell system. Each of these four fans has a diameter of 3.5 m. (11.48ft.), and delivers 25 cubic metres of air per second at a pressure of 250 mm. of water when running at 294 revolutions per minute and absorbing 160 horse-power.

Running together in parallel the two fans can deliver 40 cubic metres of air per second. A motor of 150 to 160 horse-power nominal is connected to each fan shaft. Their housings connect with passages leading to the annular tunnel ring, through which the air is driven into, or aspired from, the tunnel. In the passage is a V-shaped door which regulates the quantity of the air, moderating its velocity or changing its direction. There is a similar plant at the opposite end of the tunnel, and each portal is, we understand, to be fitted with a curtain which possibly may not be used when the tunnel is in regular working. At the time of our visit the fans at the Kandersteg portal were not running. The tunnel mouth was boarded up all over except for the small opening required for the passage of the construction trains. At the same time the fans at the opposite side—Goppenstein—were aspiring, but at a reduced vacuum. The reason for this was that there is a strong natural air current at Kandersteg when the air is induced at Goppenstein, and although the excavation works of the Goppenstein section near mid-tunnel were sweltering in heat and deficient in ventilation, yet the forcing in of air from the north end at Kandersteg, and through the gate in mid-tunnel, to improve the condition at the point named would have been attended with serious inconvenience to the workers at the excavation section of the north end. Wading through cold water, and stumbling over rocks in the stifling atmosphere of the enlargement section, while pushing towards Kandersteg, the engineer presently experiences a sudden chill as he meets a cold draught which increases to a strong piercing wind when the original narrow tunnel heading is entered. The wind at that point is sufficiently strong to extinguish the acetylene hand lamps, leaving the pedestrians to grope in absolute darkness about a place at that time distant from any work in progress. By stopping the forced ventilation at Kandersteg the risks of pneumonia were diminished.

As there was no secondary tunnel for ventilation similar to that in the Simplon, the air, during the advance in the headings, was driven to the front in a passage formed by bricking up the western side of the fully completed tunnel section—see Fig. 6. This narrow passage was termed "gaine" or sheath. It had an internal section of 6.3 square metres, or nearly 16 per cent. of the full tunnel section of 40.7 square metres, and it followed the advance of the revetment, the air from it being driven forward into the headings by means of portable fans which were moved forward from time to time with the building up of the lateral passage. At first, ventilating pipes of 450 mm. diameter were employed, then others of 467 mm, and, later still, larger ones, until the size of 580 mm. was reached, and these give the best results of all. According to the engineer in charge of the mechanical installations the ventilating pipes could hardly be made too large in view of the fact that the rapidity of advance depended to such an important degree upon the amount of air that could be got into the headings, and as so much air was lost by leakage at the joints. This loss is the most serious inconvenience met with in the ventilation, and, according to our informant, cannot be prevented in face of the rough usage, the twisting, and the battering, to which these pipes, as everything else, are subjected during the rush of work in such confined spaces.

BRIDGE BUILDING IN ALASKA.

No. II.*

The caissons for the detached ice-breakers for piers Nos. 1 and 2 were designed with the idea of not sinking them over 20ft. below the bed of the river. They were, therefore, not built as substantially as the caissons for the piers. The grillage was fastened together with screw bolts with the nuts up, in order to remove it and have continuous concrete from the cutting edge to the top of the ice-breaker. The gravel and boulders excavated in sinking these caissons were dumped inside the cofferdams for weight in sinking. On September 26th the erection of the caisson for ice-breaker No. 1 was commenced. The water in the river had fallen to such an extent at this time that the bar on which piers Nos. 1 and 2 and the ice-breakers were situated was exposed. The weather conditions from this date until April 1st, 1910, were very severe, the wind velocities ranging from 60 to 96 miles per hour for the greater part of the time, and during the period of high winds and consequent drifting snow the temperature was always low. It was therefore found necessary to build a windbreak on the up-river side of both ice-breakers to make it at all possible for men to be at work erecting and caulking the caissons and cofferdams. Even then there were many costly and exasperating interruptions by the windbreaks blowing down, necessitating a wait until the velocity of the wind became such that it was possible to put them up again. They were always re-erected under very trying and costly conditions.

On December 14th the caisson for ice-breaker No. 1 was completed and sinking began. On December 27th this caisson was landed and the sealing of the working chamber was commenced; it was completed on December 31st. The erection of the caisson for ice-breaker No. 2 was begun on November 14th, 1909, and completed on January 6th, 1910, when sinking was begun. This caisson was landed on February 3rd, and the concreting in the working chamber was completed on February 10th. The sides of these caissons were made vertical in order to simplify framing, and, owing to there being no batter on the walls, an excessive skin friction was developed. On No. 2, with a penetration of 19½ft. in the gravel and boulders, it was impossible to force the cutting edge any further down, although there was a load on the caisson which exerted a downward pressure of 1410 lb. per square foot of the exposed sides of the caisson, and the excavations inside the working chamber reached 2½ft. below the cutting edge. Ice-breaker caisson No. 1 was sunk 18ft. below the surface of the bar. On February 14th the removal of the gravel and boulders used as ballast in sinking the caissons was begun, but owing to the severe weather conditions poor progress was made, and the last of the ballast and timber grillages were not removed until March 22nd, when an attempt was made to pump out the cofferdam of No. 1, but it was found impossible. Concrete to the depth of 5ft. was then placed in the water by bottom dumping buckets, and on April 11th the cofferdam was successfully pumped out, the forms were built and concreting was commenced on April 13th and completed on April 17th. The cofferdam of No. 2 was filled in with concrete by tremies through the water to within 4ft. of the surface when the forms were built, and concreting commenced on April 25th and completed on May 1st. The entire construction of these foundations was carried on night and day, and required two shifts of men in all capacities.

On January 3rd, 1910, falsework for the erection of span No. 1 was commenced. The ice on the river at this time was 7ft. thick. Steam jets 1in. in diameter were used to thaw four holes through the ice at the point where each pile was to be driven. It only required a few minutes to thaw the holes for a pile, when it was driven to the bottom of the river. Little or no penetration was expected, or secured, on account of the large boulders of which the river bottom was composed. The ice was freezing thicker all the time until April 1st, when it had a maximum thickness of 9ft.

It had been expected that the steel for this bridge would reach the site in time to begin erection by the middle of March, but owing to delays in the shops and

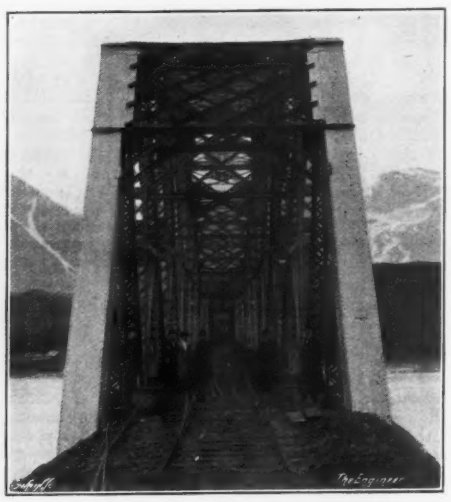
* No. I. appeared December 1st.

to snow blocks on the transcontinental roads, the steel for the first two spans did not reach Seattle until after this date. On March 15th was begun the erection of a three-bent traveller, which was designed to have sufficient clearance to erect span No. 3. On December 15th the weather turned warm and there were two weeks of heavy rain, the water flowing over the ice in the river to a depth of 4ft.

Owing to this warm weather Childs Glacier began moving forward, contracting the channel and buckling the ice in the river half a mile below the bridge. When cold weather came again, on December 30th, the face of the glacier had advanced 400ft. from its position in the latter part of August. The forward movement of the glacier stopped as soon as it became cold, but the channel had been contracted to such an extent by this forward movement and by the cakes of ice from 3ft. to 5ft. thick being turned upon edge and crowded together, that the water in the river rose gradually from April 1st, when the extreme cold weather was over, to May 6th, when the jam in front of the glacier partially broke and the water in the river was lowered 5ft. On April 1st the water in the river began rising and lifting the ice and the falsework for spans Nos. 1 and 2. Men were kept on the ice below the falsework with steam jets and chisels, welded in the ends of 1in. pipe, to clear the ice from the piling. A large force of men was required in this way night and day to prevent the ice from freezing to the piling and lifting the falsework as it rose. Even with the greatest watchfulness, the falsework would rise several inches in places, when all work would be concentrated on those points. In some instances it would not settle to its original position.

On April 5th the last of the steel for span No. 1 reached the bridge site, and the erection of this span was immediately commenced, and completed on April 18th. The steel for span No. 2 had been received in the meantime. The erection for span No. 2 was begun on April 18th and completed on April 24th. On May 6th the material for span No. 3 reached the site. On this date the jam in front of Childs Glacier was partially relieved, and the water at the bridge site was lowered 5ft., the ice in the river settled, without any movement down-stream, and rested on the shores again. This ice was 9ft thick and still as firm as in midwinter, with no indications of breaking up. In the meantime the falsework for span No. 3 had been driven, and, considering the condition of the ice, and that in 1908, with 5ft of ice, the break-up of the river did not occur till June 6th, it was thought to be safe to attempt the erection of span No. 3 on falsework. The reasons for the importance of erecting this span on falsework were :—If it were erected as a cantilever, the bridge could not possibly be opened for traffic earlier than September, 1910, and all of the construction material and supplies for the remaining 100 miles of line to be laid would have to be transferred across Miles Glacier Lake by a small barge carrying two cars at a time. For a large percentage of the time there would be so many icebergs in the lake from Miles Glacier that navigation would be impossible. These icebergs would be continually damaging the ferry slips and approaches, necessitating constant renewals and frequent cessations of navigation. Taking these interruptions into consideration, the capacity of the ferry would not be sufficient to supply the necessary construction material. When the ice went out of the lake, the ferry slips and approaches would be entirely destroyed and would have to be renewed at a cost of £9300. The probabilities were that the ferry could not be put into operation until nearly the middle of July, when the first material to be transferred would be span No. 4, one half of span No. 3, and one-half the erection device, a total of about 2100 tons. During all this time construction on the upper 100 miles of the road would be very greatly impeded, if not at a standstill. The direct saving in the cost of the bridge alone by erecting span No. 3 on falsework would be approximately £8000, and the total savings, direct and indirect, would be approximately £48,000.

On May 6th the erection of the south half of span No. 3 was commenced. It was decided to connect the south half of this span to span No. 2 by the erection device, as a matter of precaution. The sections of the lower chord of No. 3

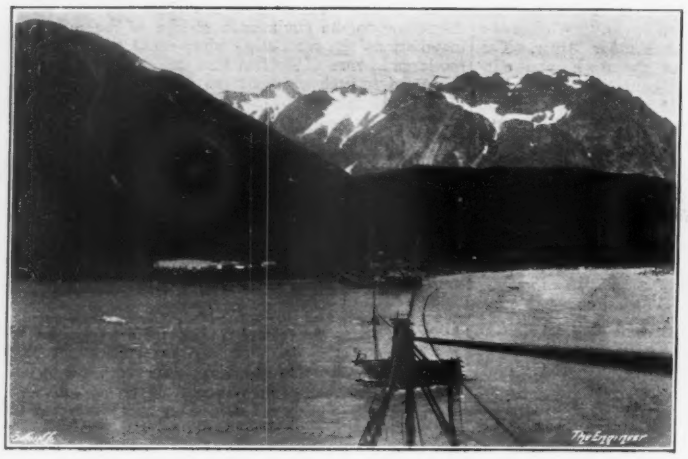


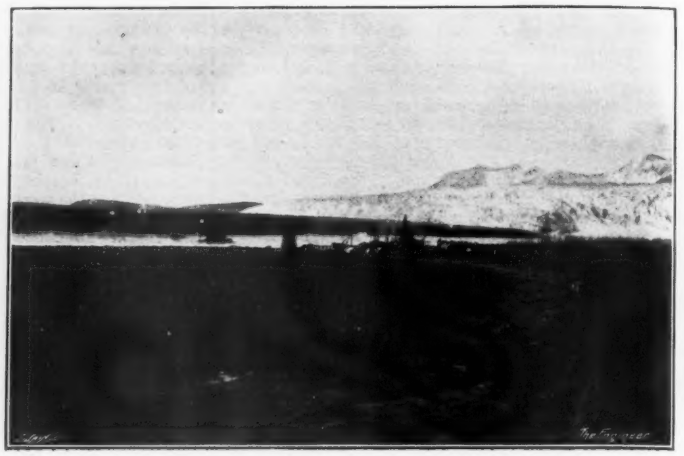
END VIEW OF BRIDGE

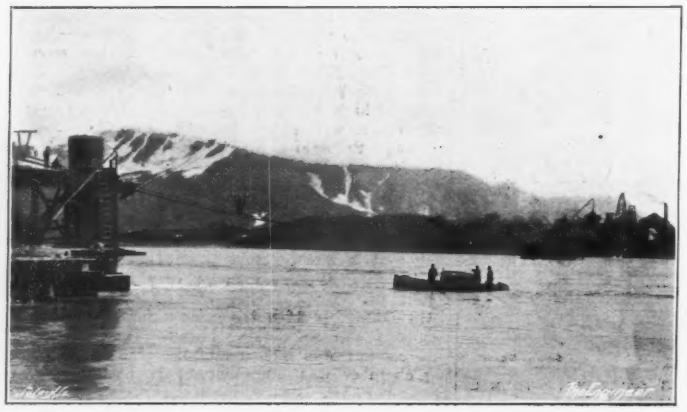
were put out on the falsework and the web members put into place, but on May 8th, before the connection was made with the erection device, the remainder of the ice jam in front of Childs Glacier went out and the ice in the river moved down-stream, carrying the falsework with it to such an extent that the outer end of the steel then on the falsework was 13in. out of line. Hydraulic jacks were used to lift the steel until connection with the erection device could be made, when the jacks were released and the erection device pulled the steel back into line. The erection of the remainder of this half of the span was completed without difficulty, after which a careful examination of the ice showed that it could not break up until it became ineffective. The jam in front of Childs Glacier was gone, but the channel ice above it was firm.

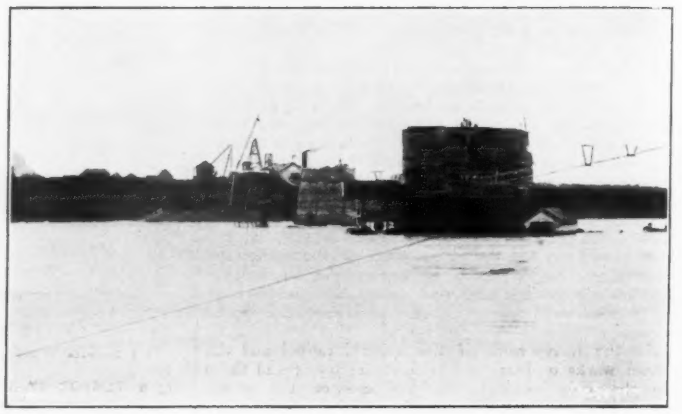
On May 11th the erection of the second half of the span was commenced, work beginning at 7 o'clock in the morning and continuing until 11 o'clock at night. On May 13th Miles Glacier began moving forward, crowding the four miles square of 9ft. ice in the lake and the connected river ice forward. This was entirely unexpected, as in the springs of 1908 and 1909 there was no forward movement of the glacier until after the opening of the river. The movement down-stream on the 13th was only 2in., but the velocity of this movement increased rapidly each succeeding day. The ice was so thick that saws were useless in cutting it, so all of the available men were put on the ice under the falsework, clearing the ice away from the up-stream sides of the piling with long ice chisels. Two shifts of thirty men each were kept at this work continuously, and succeeded in keeping the ice clear of the piling until about midnight of the 15th, when the movement of the glacier became so great that the ice gained on them slowly. Both shifts of men were kept working on the ice during the day and until midnight of the 16th. On May 13th a little over half of the second half of span No. 3 was in place, and it would have taken longer to remove this steel to a place of safety than to complete the erection. About 9 o'clock of the evening of the 14th two loading beams of the top of the traveller were broken by a lower chord section fouling when the lift was being made. By 8 o'clock of the morning of the 15th the loading beams were replaced, and the erection continued. From this time the same shift of men worked continuously on the erection until midnight of the 16th, when this span was connected and swung, and the traveller was moved over pier No. 3 on to the falsework of span No. 4. By the middle of the forenoon of the 17th the up-stream side of the falsework had moved down-stream until it was directly beneath the down-stream truss of span No. 3, and a large portion of it had collapsed. The movement of the glacier had crowded ashore large areas of the lake ice by its forward movements.

The ice in the river broke up on May 23rd. Childs Glacier immediately became very active, and in a few weeks had broken back from the river until the face of the glacier was in the approximate position it had occupied for the last three years, and the river channel was free once more. The falsework of span No. 4 was completed, pony bents were erected on it, a track laid across, and daily trains were operated over the bridge beginning with June 1st. The erection of span No. 4 was commenced on June 10th, and completed on June 19th, without any noteworthy incidents. All four spans were covered with two coats of paint. Marine tockolith was used for the









THE CONSTRUCTION OF MILES GLACIER BRIDGE

first coat and R.I.W. waterproof for the second coat of paint. This combination had stood a test of one year's exposure better than any other of twenty varieties tested.

The following is a table giving particulars of various portions of the bridge:—

Abutment No. 1.	
Elevation of bottom of masonry	112·00
Cubic yards of excavation	13,690·30
Cubic yards of concrete	2,691·69
Pier No. 1.	
Elevation of cutting edge	81·40
Cubic yards of concrete	2,588·90
Skin friction just before landing caisson per square foot, lb.	620
Icebreaker No. 1.	
Elevation of bottom of masonry	99·00
Cubic yards of concrete	1,240·10
Pier No. 2.	
Elevation of cutting edge	81·95
Cubic yards of concrete	2,798·30
Skin friction just before landing caisson per square foot, lb.	1,101
Icebreaker No. 2.	
Elevation of bottom of masonry	99·00
Cubic yards of concrete	1,587·80
Pier No. 3.	
Elevation of cutting edge	72·76
Cubic yards of concrete	2,927·60
Skin friction just before landing caisson per square foot, lb.	617
Abutment No. 2.	
Elevation of bottom of masonry	116·83
Cubic yards of excavation	9,794·70
Cubic yards of concrete	2,311·90
TOTAL CUBIC YARDS OF CONCRETE	16,146·2
Weights of Steel.	
Span No. 1	2,311,053
Span No. 2	1,568,553
Span No. 3	3,005,991
Erection device	520,349
Span No. 4	2,421,180
TOTAL WEIGHT OF STEEL	9,827,126

THE MALLET LOCOMOTIVE ON AMERICAN RAILWAYS.

No. 1.

THE Mallet articulated locomotive—invented by M. Mallet in France about twenty-five years ago, and used to a greater or less extent in many countries of the world—has found a specially appreciative recognition and home in the United States. The first American engine of this type was not put in service until late in 1904, having been a prominent feature of the extensive exhibit of locomotives at the St. Louis International Exhibition of that year. This was a 120-ton engine of the 0–6–6–0 class for banking work. Since then, however, the type has come rapidly into favour, and to-day it is to be numbered by hundreds, while its use is increasing continually. These Mallet locomotives range from a 63-ton engine for operating on forest and light railways, to a 250-ton 20-coupled monster for hauling enormous goods trains over mountain divisions having very heavy gradients and sharp and numerous curves. The majority, however, range from 130 to 180 tons—English—and are used either for hauling heavy goods trains on lines having the conditions noted above, or for banking heavy trains—hauled by ordinary locomotives—on individual steep and long gradients, which otherwise would limit the weight of trains or necessitate their being split at the incline. Some railways have only a few Mallet engines, which are used for special work. Others use them more extensively and have from 20 to 50 engines each. One of the latter lines is now proposing to operate a service of 2200-ton through goods trains by Mallet engines ranging from the 2–6–6–2 type in ordinary country to 2–10–10–2 type in districts where gradients are severe. This service will require some 300 engines, the length of main line being approximately 2200 miles between termini.

There are two leading reasons for this wide adoption of the Mallet locomotive by American railways:—First, the severe conditions of gradient and curvature which exist on many main lines, either for short distances or over entire divisions; secondly, the general policy of effecting economy in transportation expenses by concentrating the through goods traffic into trains of great weight, and thus lessening the cost per ton-mile. With an increase in train tonnage, under this policy, there is a reduction in engine mileage, train mileage, wages, fuel, and engine repairs. To a great extent this policy has been followed out in the use of increasingly more powerful engines of the ordinary type. But these are reaching a limit, owing to the length of wheel base and the weight per axle, the length of rigid wheel base being a specially important factor where the curves are sharp and numerous.

Locomotives with five driving axles are in use to some extent and represent about the limit for engines of the ordinary type. Probably the largest of these engines are the four-cylinder tandem compound 2–10–2 locomotives of the Atchison, Topeka, and Santa Fé Railway, having a rigid wheel base of 19ft. 9in. and a total wheel base of 35ft. 11in. These engines have cylinders of 19in. and 32in. diameter and 32in. stroke, 4800 square feet of heating surface, and a weight of 128 tons, of which 105 tons are on the drivers. The tractive force is 62,800 lb. These engines are exceptional, however, and as a general rule the ordinary powerful goods engine has four driving axles—2–8–0 or 2–8–2—and does not exceed 45,000 lb. in tractive force. The weight of such engines is higher per unit of power than in the Mallet type.

The special features of the Mallet type are:—(1) The concentration of power and weight; (2) the distribution of this weight over a number of driving axles, so as to keep the axle loads and journal loads within limits suitable to the construction of the road; and (3) the arrangement of these axles in separate articulated units, so that the engines can safely negotiate severe curves at ordinary speeds and with a minimum of wear upon rails and wheels. The Mallet system, with only one steam bogie, is simpler than the Fairlie system with two steam bogies. The latter system was in use at one time, many years ago, on part of the narrow gauge lines of the Denver and Rio Grande Railway, but the engines—of a small size—were abandoned many years ago. Under existing conditions of traffic, this line is now introducing powerful Mallet engines for operating heavy train loads over severe gradients on its standard gauge main lines. The Mason-Fairlie engines used at one time in America had a single steam bogie and a trailing carrying bogie. As these were small engines for branch and suburban working, and were designed with a view to flexibility rather than power, they need not be more than mentioned here.

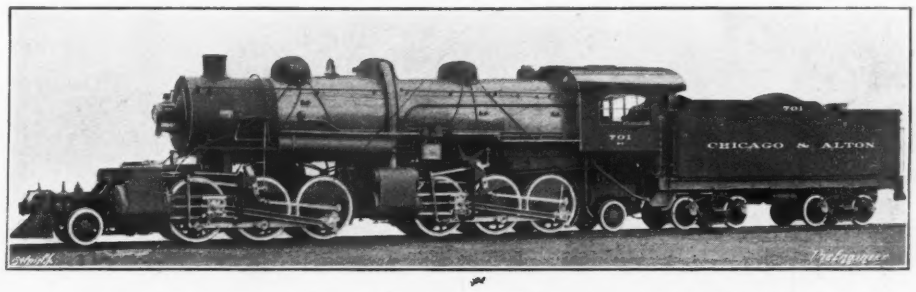


Fig. 1—146-TON MALLET LOCOMOTIVE CHICAGO AND ALTON RAILWAY

The Mallet engines of American railways, ranging—as has been said—from 63 tons to 250 tons, exclusive of tender, are of the following types, classified according to their wheel arrangement:—

2— 4— 4 - 2
4— 4— 6 -2
0— 6— 6—0
2— 6— 6—2
2— 6— 8—0
0— 8— 8—0
2— 8— 8—0
2— 8— 8—2
2—10—10—2

Most of those in use have been built by the Baldwin Locomotive Works and the American Locomotive Company, both of which have also built large and small Mallet engines for export.

The use of the Mallet engine is not confined to steep gradients, but is found on some lines which are of a comparatively easy character, but which handle extremely heavy traffic—in some cases a heavy through coal traffic. Under such conditions the reduction in number of trains to handle a given tonnage is of great importance. On the Chesapeake and Ohio Railway the maximum gradients negotiated by the Mallet engines are 1 in 166, but their coal trains weigh 3000 tons. The curves are of about 1050ft. radius. These engines are of the 2–6–6–2 type, weighing about 180 tons; their cylinders are 22in. and 35in. diameter by 32in. stroke, driving wheels 4ft. 8in. diameter, and the boiler has 6000ft. of heating surface, with 72 square feet of grate. On the Carolina, Clinchfield and Ohio Railway—which is essentially a coal road—the maximum gradient against the loaded trains is 1 in 200, but 2–6–6–2 Mallet 175-ton engines are used in order to concentrate the traffic in very heavy trains. The Burlington Railway has about 20 engines of the same type, operating on a line having gradients of 1 in 62 and curves of 285ft. radius.

For still heavier work the St. Louis and San Francisco Railway has Mallet engines of the 2–8–8–2 type, which—at 10 miles an hour—have a capacity for hauling trains of 1600 tons behind the tender on gradients of 1 in 66 and 1000 tons on 1 in 44; at five miles an hour they can handle 1950 tons and 1230 tons respectively on these inclines. On the Denver, North-Western and Pacific Railway there are long gradients of 1 in 30 to 1 in 25, and here Mallet locomotives of the 0–6–6–0 type are used for banking the standard goods trains of 730 tons, which can be handled on the remainder of the line by the regular 2–8–0 engines. When used as train engines the Mallet locomotives can take 470 to 500 tons—behind the tender—up these gradients. These engines weigh 147 tons; they have cylinders 21in. and 33½in. diameter by 32in. stroke, 55in. driving wheels, and a rigid wheel base of only 10ft. The long inclines have numerous curves of 350ft. to 360ft. radius. In descending such inclines the Mallet engines have a special advantage in their great braking power to control the trains. On the Great Northern Railway 170-ton 2–6–6–2 Mallet locomotives, with 150 tons on the drivers, are rated at 1600 tons of train load on 1 in 100, and two of the engines handle the same train on 1 in 45 at a minimum speed of eight miles an hour. Similar engines on the Northern Pacific Railway take 850 tons up 1 in 45. On the Southern Pacific Railway a 210-ton 2–8–8–2 engine, with 190 tons on the drivers, has hauled 1105 tons of train load at an average of 9¼ miles per hour on gradients of 1 in 45. A similar engine of 225 tons, with 206 tons on the drivers, has handled 1180 tons at 10 miles an hour on gradients of the same inclination on the Atchison, Topeka and Santa Fé Railway. Still, other engines of this same type on the Virginian Railway—which is a coal line—haul 1560-ton coal trains up gradients of 1 in 50. These figures give some idea of the performance of Mallet locomotives in regular service on American railways.

A 63-ton Mallet engine of the Little River Railway is shown in one of the engravings on page 590 as representative of the smaller engines of this class. The railway is used mainly for hauling timber, and has a light permanent-way construction with numerous sharp and irregular curves. It is of the 2–4–4–2 class, with an average driving axle load of only 12½ tons. A number of similar engines are used on other railways of the same character. The second engraving on page 590 shows a larger engine of the 2–6–6–2 class for the same kind of service. It is a tank engine, with side tanks and rear bunker, the latter being a tank for oil fuel with a rack for wood fuel. Its driving axle load is about 13 tons. The engine works on 56 lb. rails, and the line has gradients of 1 in 16 with curves of 164ft. radius. The engine is capable of ascending gradients of 1 in 10. The dimensions of these engines

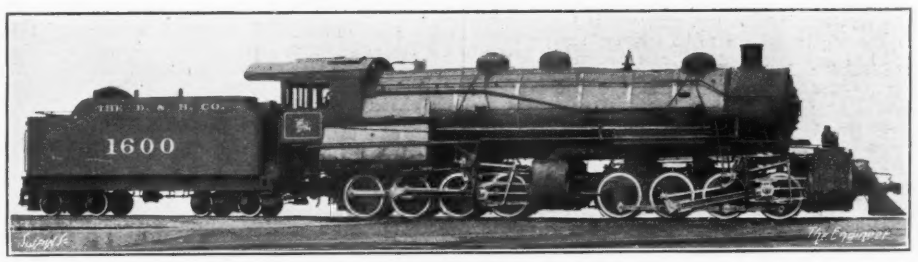


Fig. 2—200-TON MALLET LOCOMOTIVE, DELAWARE AND HUDSON RAILWAY

are given in the table on page 584. Fig. 1 shows an engine of the 2–6–6–2 type for the Chicago and Alton Railway, handling coal trains on a line with favourable conditions on the average and where the gradients do not exceed 1 in 110. This is an engine of 146 tons, with 128 tons on the drivers, 8½ on the leading bogie and 9½ on the trailing bogie. The driving wheels are 5ft. 3in. diameter, with 11ft. rigid wheel base and 48ft. engine wheel base, or 76ft. 8in. for engine and tender. The cylinders are 22in. and 35in. diameter and 30in. stroke. Boiler, 6ft. 3in. diameter, with fire-box 9ft. by 5½ft., and 406 tubes, 2in. diameter and 21ft. long. Heating surface, 4466 square feet, for the tubes and 300 for the fire-box, or 4766 square feet in all; grate surface, 49¾ square feet. The tractive power is 61,650 lb. The double-bogie tender carries 14 tons of coal and 8500 gallons of water.

A very heavy Mallet engine for banking coal trains on the Delaware and Hudson Railway is shown in Fig. 2. The Jefferson division—95 miles—has a very heavy coal traffic, but for 20 miles there is a continuous incline beginning with 1 in 74 for six miles and then 1 in 120. The regular train engines are of the 2–8–0 type, weigh 112 tons, with 100 tons on the drivers, and having a maximum tractive effort of 49,690 lb. Such an engine can handle a train of 2600 gross tons behind the tender, except on this incline, where two similar engines had formerly to be added to assist in banking. With the three engines the speed was about 10 miles an hour on the 1 in 74 and 15 miles on the 1 in 120 stretch. In order to reduce the operating expenses and to facilitate the train service, experiments were made with a Mallet engine for banking with such successful results that six such engines of the 0–8–8–0 type were ordered from the American Locomotive Company. The total weight is very nearly 200 tons; the maximum tractive power is 105,000 lb. when working compound, and this can be increased to 126,000 lb. when working simple. With the same average axle load as the 2–8–0 engines, and with a rigid wheel base 2ft 3in. shorter, the Mallet engines have more than twice the power of the former, and can increase this to 2½ times the power if required. The six 0–8–8–0 Mallet engines take the place of twelve 2–8–0 engines formerly retained for banking work. Their dimensions are given in the table. The

length over all is 90ft. 6in., extreme height 16ft., and extreme width 11ft. 4in.

The frames of these engines are of vanadium cast steel with numerous cross braces. The rear end of the steam bogie has a radius arm which enters a pocket on the end cross brace of the main frames, the pivot pin passing through the top and bottom of the pocket and the radius arm. To steady the bogie in swivelling, its rear cross brace has two horizontal projections which bear against spring buffers on the cross brace of the main frames, so that as the bogie swings one or other of the buffers is compressed. The saddle supporting the boiler upon the bogie must have a sliding motion to allow for the movement of the bogie. In order to reduce the load on the sliding surfaces there is a floating balance support—shown in Fig. 3—consisting of two vertical bars A, with hemispherical ends fitting into cup bearings B on the saddle,

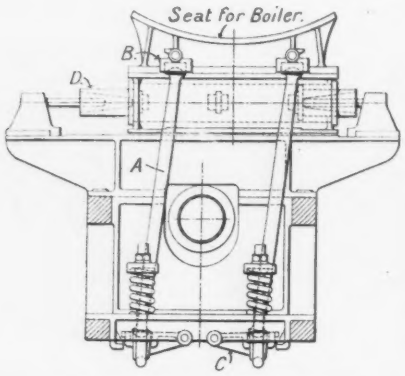


Fig. 3—FLOATING BALANCE SUPPORT

and into hinged and spring supported shoes C on one of the cross frames. Centring springs D steady the saddle. This drawing shows the centre line of the boiler and saddle offset to the right of the centre line of the bogie. The total initial compression on the four springs is about 30,000 lb., by which amount the pressure on the sliding surfaces of the saddle is relieved.

The boiler has tubes of unusual length, 24ft.; these do not start at the fire-box, but at an oval combustion chamber 4ft. long, forming an extension of the fire-box, and projecting into the boiler barrel. The arrangement of the steam pipes is somewhat unusual. From the regulator a pipe leads inside the boiler to a branching pipe in the smoke-box, and from each side of this branch pipe or Y an outside pipe under the running board returns to the high-pressure cylinders. The regulator—Fig. 4—takes steam only at the top, where it is fitted with a baffle, causing the steam to be diverted sharply downward, while any entrained water is thrown against the

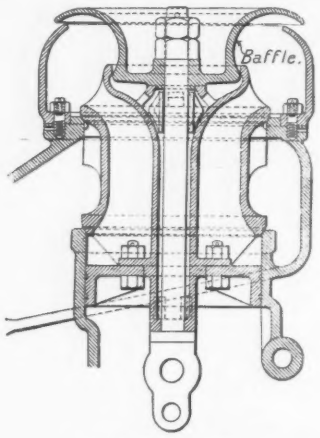


Fig. 4—REGULATOR

curved surface of the baffle. The high-pressure cylinders have 14in. piston valves, and their exhaust goes by a branch pipe to a receiver pipe leading forward to the steam chest of the low-pressure cylinders on the bogie. One of the high-pressure steam passages is connected also to the intercepting valve for admitting live steam to the low-pressure cylinders. These latter cylinders have double-ported slide valves, and are fitted with by-pass or relief valves to prevent any pumping action of the large pistons when the engine is drifting or running with steam shut off. Flexible spherical and slip joints are provided in the receiver pipe and low-pressure exhaust pipe. The Walschaerts valve gear is used for both sets of cylinders, and reversing is effected by a hydro-pneumatic gear having two tandem cylinders, one for oil and one for compressed air.

The Southern Pacific Railway has a number of Mallet engines of the 2–8–8–2 class, and a number of them are arranged to run with the cab in front, as shown on page 590. This is to give the drivers a better view of the line, which is especially important on this line on account of the numerous tunnels and snow-sheds. These engines burn oil fuel. They operate on the Sacramento division, having about 40 miles of gradients of 1 in 45. Their dimensions are given in the table.

A Mallet engine of very exceptional type is also shown on page 590, and is one of two engines built for operating fast and heavy through passenger trains over a division of the Atchison, Topeka, and Santa Fé Railway which has gradients of 1 in 55 to 1 in 60, but on which an average speed of 25 miles an hour must be maintained. The engine is of the 4–4–6–2 type, having a four-wheeled leading bogie, a four-wheeled steam bogie, six driving wheels in the main frames, and a two-wheeled trailing bogie. Like most of the Mallet locomotives on this line, the equipment includes a superheater, a re-heater for the high-pressure exhaust, and a feed-water heater. The dimensions are given in the table. These engines are notable also for their very large tenders, with great tank capacity—12,000 gallons. This is due to the large requirements for water of such engines, and to the fact that water is scarce along the division where these engines work. The tender weighs about 100 tons. It is 37ft. 6in. long over the frames, and is mounted on a pair of six-wheeled bogies spaced 20ft. 6in. between centres. The bogie wheel base is 10ft. 6in., and the total wheel base of tender is 31ft.

Some railways in adopting the Mallet type of locomotive have utilised existing simple locomotives by converting them to compound duplex engines. For this purpose a new unit is built for the forward section, comprising the steam bogie with its low-pressure cylinders and boiler extension. The original engine—with its leading bogie removed—then forms the rear section, with the steam generating portion of the boiler, the rigid frames and the high-pressure cylinders. A new front-end section of this sort is shown in Fig. 5.

On the Great Northern Railway, engines of the 2–8–0 class have in this way been converted into Mallet engines of the 2–8–8–2 type; on other railways engines have been converted to a 2–8–8–0 type, no trailing bogie being added. The Chicago Great Western Railway has similarly converted 2–6–2 simple engines to 2–6–6–2 Mallet engines. The original engines had cylinders 21in. by 28in., driving wheels 5ft. 3in. diameter, and 70 tons on the drivers. The converted engines have wheels of the same size, cylinders 21in. by 28in. and 35in. by 28in., and a weight of only 67 tons on each group of driving wheels. The tractive force is increased from 33,000 lb. to 52,000 lb. The generating portion of the boiler remains unaltered; it is able to supply sufficient steam by the economies due to the compound system and the large amount of heating surface in the feed-water heater of the boiler extension. This has 400 tubes, 2in. diameter and 9ft. long, and is estimated to be equivalent to an addition of 1700 square feet to the normal tube heating surface. Thus the total heating surface is increased to 5078 square feet.

In some Mallet banking engines of the Canadian Pacific Railway an unusual cylinder arrangement is used. The high-pressure cylinders are placed in front of their wheels in the usual way, but the low-pressure cylinders are placed at the rear end of the steam bogie. The cylinders are far enough apart to allow of the removal of the pistons. This arrangement simplifies the steam piping considerably. The high-pressure exhaust is delivered into a single chamber, which is connected to a similar chamber in communication with the steam passages of the low-pressure cylinder by means of a receiver pipe. This pipe is an upright inverted U, curved laterally to fit the boiler; the connection to the bogie is made directly over the pivot of the latter. In the low-pressure exhaust pipe the angular movement on a curve of 285ft. radius is only 2½ deg., which can be taken up by a ⅜in. movement in the joint. With the ordinary arrangement the angular movement would be about 15 deg., with an extension of 1⅜in. in length, requiring a packed expansion joint. When pushing a train on 1 in 45 gradients there is no stress in the pivot pin, as the pivot casting at the rear then comes in contact with the corresponding casting on the bogie.

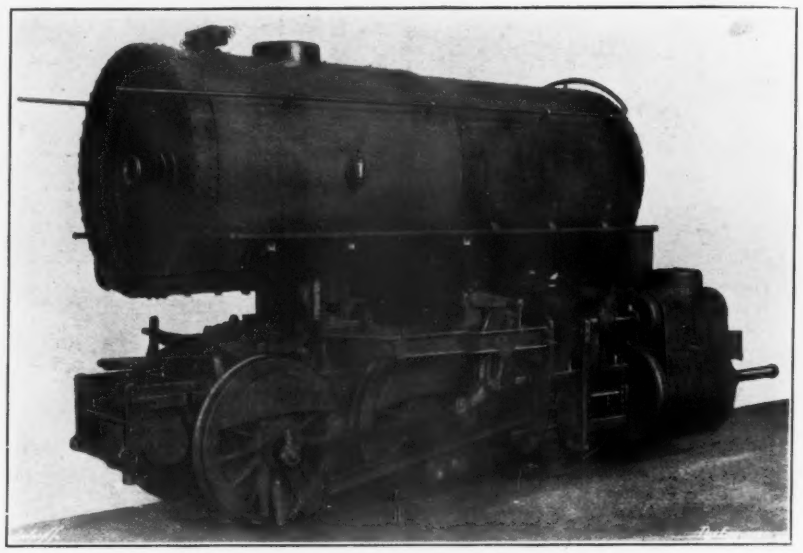


Fig. 5—FRONT END SECTION FOR MALLET LOCOMOTIVE

Types of Mallet Articulated Locomotives on American Railways.

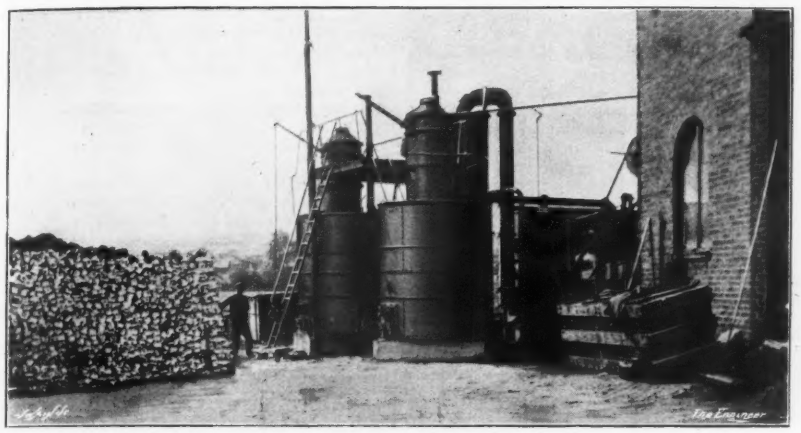
Railway.	Little River.	Booth-Kelly.	A.T. and S.F.	Gt. Northern.	Del. and Hudson.	So. Pacific.	A.T. and S.F.
Type of engine	2-4-4-2	2-6-6-2	2-6-6-2	2-6-8-0	0-8-8-0	2-8-8-2	4-4-6-2
Weight, total, tons, English	63	92	175	170	200	195	168
,, on drivers, tons, English	50	79	142	160	200	176	119
,, engine and tender, tons, English	100	Tank	251	235	275	270	270
Cylinders, high-pressure, in.	14 × 22	17 × 24	24 × 28	23 × 32	26 × 28	26 × 30	24 × 28
,, low-pressure, in.	21 × 22	26 × 24	38 × 28	35 × 32	41 × 28	40 × 30	38 × 28
Driving wheels	3ft. 8in.	3ft. 8in.	5ft. 9in.	4ft. 7in.	4ft. 3in.	4ft. 9in.	6ft. 1in.
Bogie wheels	2ft. 2in.	2ft.	2ft. 7in.	2ft. 6in.	—	2ft. 6½in.	2ft. 7½in.
Trailing wheels	2ft. 2in.	2ft. 2in.	3ft. 4in.	—	—	2ft. 6½in.	4ft. 2in.
Wheel base, rigid	5ft.	8ft.	13ft. 8in.	10ft. and 15ft.	14ft. 9in.	15ft.	6½ft. and 12⅝ft.
,, driving	18ft.	23ft. 8in.	37ft. 10in.	35ft.	40ft. 2in.	39ft. 4in.	30ft. 4in.
,, engine	32ft. 10in.	37ft. 9in.	56ft. 3in.	44ft.	40ft. 2in.	56ft. 7in.	51ft. 11in.
,, engine and tender	54ft. 6in.	—	89ft. 3in.	76ft.	75ft. 7in.	83ft 3in.	94ft. 6in.
Boiler, diameter	4ft. 6in.	5ft.	5ft 10in.	7ft.	7ft 6in.	7ft.	6ft.
Steam pressure, lb.	200	200	220	200	220	200	200
Fire-box, inside, in.	74 × 42	90 × 42	120 × 63	117 × 96	126 × 114	126 × 78	120 × 63
Tubes, number	170	221	294	32 and 275	446	401	294
,, diameter, in.	2	2	2¼	5 and 2¼	2¼	2¼	2¼
,, length	16ft.	17ft.	19ft. 7in.	15ft.	24ft.	21ft.	19ft.
Feed-water heater tubes, number	—	—	322	582	—	401	314
,, ,, ,, diameter, in.	—	—	2¼	2¼	—	2¼	2¼
,, ,, ,, length	—	—	9ft. 10in.	5ft. 2in.	—	5ft. 3in.	7ft.
Heating surface, tubes, sq. ft.	1417	1957	3376	3038	6276	4941	3275
,, arch tubes, sq. ft.	—	—	34	—	—	—	
,, fire-box, sq. ft.	101	132	200	225	353	232	202
,, feed-water heater, sq. ft.	—	—	1893	1777	—	1220	1279
,, total, sq. ft.	1518	2089	5503	5040	6629	6393	4756
Superheating surface, sq. ft.	—	—	390	480	—	None	323
Re-heating surface, sq. ft.	—	—	719	—	—	655	798
Grate surface, sq. ft.	21½	26⅓	52½	78	100	68½	52½
Coal or oil on tender	7 tons	1000 gals.	12 tons	13 tons	14 tons	3150 gals.	4000 gals.
Water on tender, gals.	4000	2000	9000	8000	9000	9000	12,000
Tractive force (compound), lb.	23,500	37,800	61,500	73,800	105,000	85,500	53,000

GREAT EASTERN RAILWAY LOCOMOTIVE DEPARTMENT.—The eighth annual reunion dinner of past and present members of the locomotive department staff of the Great Eastern Railway was held in the Norfolk Room of the Great Eastern Hotel, Liverpool-street, on the 24th November, 1911, Mr. A. J. Hill, works manager at Stratford, in the chair. The gathering numbered fifty-three, drawn from many parts of the kingdom, and letters of regret at inability to be present were read from a number of others. The toast list was as follows:—"His Majesty the King;" "The Queen, Queen Alexandra, the Prince of Wales, and other Members of the Royal Family" (proposed by the chairman). "Old Stratfordonians all over the World" (proposed by Mr. F. V. Russell, and replied to by Mr. J. A. Mills). "The Great Eastern Railway and Present Stratford Men" (proposed by Mr. Godfrey Elliot, and replied to by Mr. E. Winmill). "Our Chairman" (proposed by Mr. J. Holden, J.P., and replied to by Mr. Hill). An excellent musical programme was given during the evening.

POWER FROM PEAT.

A PEAT power plant has been working at the factory of Mr. Hamilton Robb at Portadown since the early part of September, with, we are informed, entirely successful results. The plant, which has a capacity of 400 brake horse-power, consists of two gas producers, each of 200 brake horse-power capacity, coke scrubber, tar extractor, sawdust scrubber, exhauster, and expansion-box.

Mr. Robb has always had a firm conviction that sooner or later he would be able to run his factory with peat from his own boglands at Maghery as fuel. About eighteen months ago he accordingly discussed the matter with Mr. Pegg, of the firm of T. L. Miller, Wilson and Pegg, consulting engineers, of Belfast, Liverpool, and Manchester, and it was decided to send some four tons of peat from the Maghery boglands to Crossley Brothers, Limited, of Openshaw, for experimental purposes. Mr. Pegg had had some experience in the use of peat for this purpose, having, as long as six years ago, succeeded in running a factory, of which he was then works manager, for some ten days on peat gas. He had encountered a number of difficulties, and these, with the active co-operation of Messrs. Crossleys, he set himself to overcome. A test was run with the experimental plant at Openshaw in December last, and the result was deemed sufficiently satisfactory for Mr. Robb to be advised to install a 400 horse-power plant for his factory. The result was not achieved without it being found necessary to make sundry alterations in the design of the apparatus, as the experimental plant had not originally been designed to deal with peat, but these matters were satisfactorily settled by Messrs. Crossley and Mr. Pegg, and the plant was put in hand and delivered in August last. We give a view and drawing of the producers in the accompanying engravings.



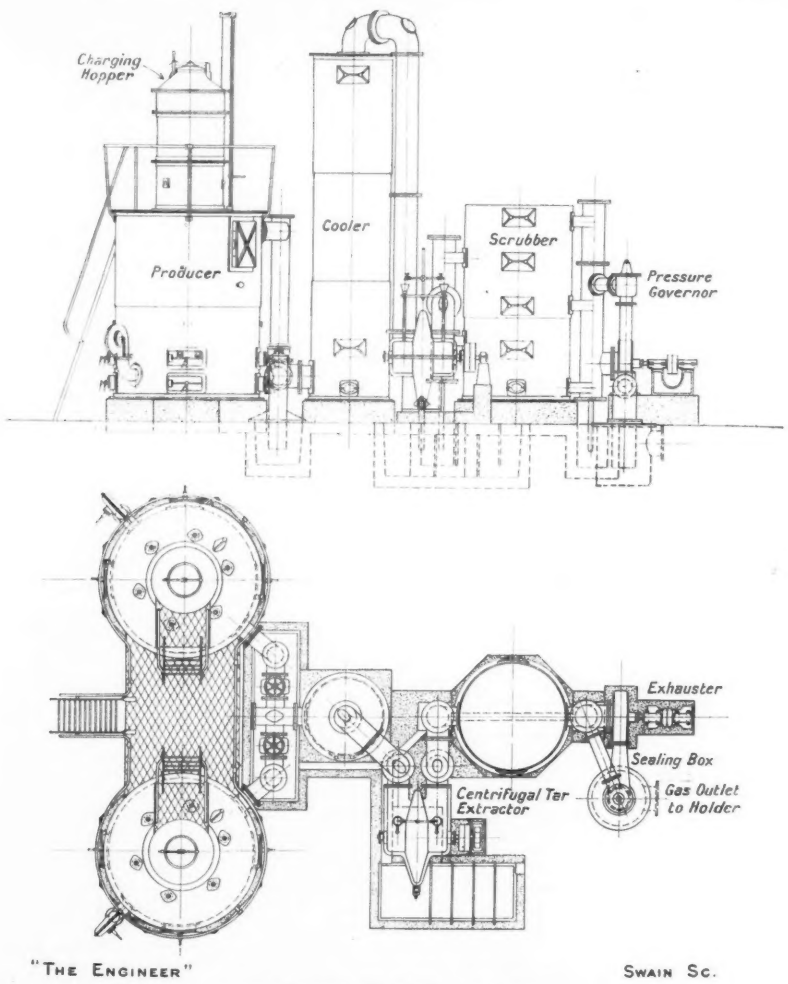
PEAT GAS PRODUCER

Its operation is extremely simple. The peat is fed by hand into hoppers at the top of the producer, from which it falls by gravitation into the body of the producer as combustion of the lower layers of peat takes place. The gas as it is formed passes through the coke scrubber to the tar extractor, where the tar is separated from the gas by centrifugal action. The gas then passes to the sawdust scrubber, where the final cooling and cleaning take place. It is drawn through the plant by an exhauster in the form of a high-speed fan, which delivers it to a gasholder for use in the engines.

The nature of the gas produced is similar to that of suction gas from Welsh anthracite, though it contains a smaller percentage of hydrogen gas, and the thermal value is slightly more—about 140 B.Th.U.

The peat fuel is cut from the boglands at Maghery and dried by the ordinary open-air method. In this way the peat, which originally contains about 85 per cent. of moisture, can be dried during an average drying season to contain about 26 per cent. of moisture. During the last exceptional summer the peat was actually dried in the open air to such an extent that it contained as little as 19 per cent. of moisture, as shown by chemical analysis. The plant, however, is designed to work with peat containing up to 45 per cent. of moisture, though naturally it would not be so economical to use peat in such a wet state, because, for one thing, of the excessive cost of carriage in proportion to the effective fuel contained in it. It is interesting to know, however, that the plant will work with such wet peat, for the climate of peat-producing countries is very rarely dry.

The cost of the peat as delivered on the site at Portadown is 6s. per ton, and the amount of peat consumed per week with an average load on the plant of 275 brake horse-power is slightly under 20 tons. The prime cost of the fuel is therefore £6, but from this must be deducted the value of the tar recovered from the plant, which averages 35s. per week, which leaves the net cost of the fuel at £4 5s. We are informed that the factory engines were, previously to the introduction of the peat plant, driven by a coal gas plant which used 8¼ tons anthracite per week at a cost of £13 16s. 3d. With the peat plant, as it is worked at present, one more labourer is required than was found necessary with the anthracite plant, but it is thought that it may be found possible to dispense with this additional labour later on; but allowing £40 per annum for additional wages the saving effected in the cost of fuel in a factory which contains 500 looms and employs from five to six hundred hands is well over £400, as shown by the above figures.



ARRANGEMENT OF PEAT GAS PLANT

As regards the working of the plant, the anthracite plant has been kept as a stand-by, and although we gather that it is not now ever called upon, it was found very useful in the early stages of handling the peat plant and before the men got used to the latter. The initial difficulty was in learning how to control the amount of gas made, as sometimes it was altogether in excess of requirements, and other times it was entirely insufficient. One of the earliest troubles was experienced from a very unexpected cause. Owing to the exceptionally dry summer, the peat which had been stacked to dry near the shores of Lough Neagh had become considerably impregnated with sand blown from the shores of the Lough. This sand collected on the grate bars of the producer in the form of a crude black glass, which blocked up the interstices completely and stopped the generation of gas. This trouble was quickly cured by adjusting the amount of air admitted between the bars, and by introducing a certain amount of water vapour into the main air supply to the producers, and no further trouble has been experienced from this cause.

When the plant was originally put down it was arranged to cut the peat fuel into blocks of about 5in. cube before feeding it into the hoppers. This procedure being found troublesome and expensive, the feed hoppers were altered and the peat is now fed in blocks exactly as they come from the boglands.

The only other trouble experienced has been in connection with the coke scrubber. As the gas passes through this before it reaches the tar extractor a large amount of tar was thrown down on the coke, especially on the bottom layers, and the scrubber became so rapidly choked that it required attention every five to six days. Eventually the scrubber was modified so as to act as a washer and cooler, the major portion of the coke being removed, and the gas being made to pass upwards against a descending shower of water. The removal of the coke had a double advantage, inasmuch as not only was the initial expense of the material saved, but more tar was thrown out by the tar extractor instead of being deposited in a worthless condition on the coke.

The amount of tar recovered is about 5 per cent. of the weight of the fuel consumed, or, say, one ton per week. It is all being sold, and is at present realising about 35s. per ton. The tar, on analysis, was shown to contain a slight amount of paraffin wax, and a considerable proportion of heavy oils distilling above 270 deg. Cent.

We have been supplied with a copy of an analysis of the tar, which was made by Messrs. Totton and Hawthorne, analytical and consulting chemists, of Belfast, and we reproduce it below:—

Sample of Tar. No. 1.

On distillation the following fractions were obtained:—

	Per cent.
(1) Water	49.7
(2) Light oils (distilling below 230 deg. Cent.)	5.8
(3) Middle oils (distilling at 230-270 deg. Cent.)	8.0
(4) Heavy oils (distilling above 270 deg. Cent.)	19.4
(5) Coke (left in retort)	10.3
(6) Loss	6.8
	100.0

Much frothing occurred during the distillation owing to the large amount of water present. The final temperature registered by the thermometer was 325 deg. Cent.

The same analysts have also analysed the peat itself, and we give below a record of the results they arrived at:—

Sample of Peat.

(Received on 14th September from Mr. Hamilton Robb, Portadown.)

PROXIMATE ANALYSIS:	Per cent.
Water	18.98
Volatile matter	55.17
Fixed carbon	24.75
Ash	1.10
	100.00
ULTIMATE ANALYSIS:	
Carbon	44.60
Hydrogen	5.42
Nitrogen	0.97
Ash	1.10
Moisture	18.98
Oxygen (by difference)	28.93
	100.00

This plant, which is claimed to be the only instance in the British Isles of the direct commercial utilisation of peat for power purposes, is now working daily, and giving no trouble whatever. The only operations required are the stoking of the plant and the cleaning of the ashpits. Owing to the open nature of the fuel, it is found that no "poking," such as is necessary with coal plants, is required, which, of course, simplifies the operation of the plant.

ENGINEERING STANDARDS COMMITTEE: REPORT NO. 55.—The latest report of the Engineering Standards Committee deals with the subject of the strength of hard-drawn copper and bronze wire. Experiments have recently been carried out on this subject for the Committee at the National Physical Laboratory, and have been conducted with funds provided by the General Post-office and the National Telephone Company. The wires tested were of small diameter, such as are used in telegraph and telephone work, and their mechanical properties as influenced by differences of make and variation in diameter, length, and temperature were examined. The experiments also covered the investigation of the influence of kinking on the strength of the wires. This defect, it appears, has a greater influence on the strength of wire than has generally been realised. It would be well if wire makers were to study this report carefully. The suggestion that the class of wire dealt with should be wound on coils of larger diameter than is usually the case in order to lessen the weakening defects of kinking is especially worthy of attention from manufacturers. The report includes a description of the testing arrangements and several tables and curves showing the results of the experiments. It is published at 10s. 6d. net by Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C.

THE GERMAN INSTITUTION OF NAVAL ARCHITECTS.

No. II.*

We give now Professor Junker's reply to the discussion on his paper reported in our last issue. The principal disadvantage of his design was, he said, considered to be its great height. But this was a mistake. When an engine had two pistons it became, not higher, but lower, for when a stroke was divided into two parts these did not become longer, but shorter; the engine would have the length of a steam engine. A tandem engine was from seven and a-half to eight times as long as its stroke, and that was not longer than in the case of the engine with double-acting pistons. The engine was shorter than any other having the same stroke. Then fault had been found with the rod arrangement. There were four piston-rods in place of one! This assertion was not justified. It was well known that a single small part might influence reliability in working to a much greater degree than a large piston-rod. Every single part must be treated as a factor; only then could a correct judgment be formed. Then something had been said about rattling and shaking; it had been said that if the tension-rods did not pass exactly through the middle they would jam; but the forces here always acted centrally. Again, the number of the journals was found fault with; distinction must, however, be made as to whether a journal worked and was subject to constant friction, or whether it only had to provide for small degrees of motion. Such diverse cases could not be compared. With regard to the stuffing-boxes, he would give no opinion; that was a matter for the practical man. Great improvements were being made in that domain, and he had nowhere said that stuffing-boxes could not be made in such a way as to meet the requirements of Diesel motor work; it was well, however, to avoid their use if possible. Herr Toussaint had questioned the correctness of the design of his engine, and had based his strictures on experience of such a general nature that it was impossible to follow him. He must ask Herr Toussaint to give him more exact particulars. Herr Meyer's investigations, on which Herr Toussaint based his remarks, were very excellent; he himself had a high opinion of them, but he could not accept his conclusions. He wished to thank Direktor Saiuberlich for his kind remarks. He could not agree with all the observations of Herr Regenbogen. It had been asserted that the large gas engine must not be so highly stressed; experience must show whether the 14 to 15 atmospheres were admissible; he had obtained his experience under small-scale conditions with a 40 horse-power engine. Dr. Rieppel had asserted that the consumption of lubricating oil would be very large in his engine; the double piston engine was in this respect, however, exceptionally favourably situated. The piston supplied oil to the bearing surface, and the oil was the best lubricant possible, as it came from the hot region into the cold, and the lubricating oil applied led from the cold into the hot part. This point, indeed, was particularly in favour of the double piston, and the conditions were better than with a single one. Then the rod arrangement was condemned, and in particular the shaft. The object of a prime mover was to produce a turning moment, and this was attained most thoroughly when pushing and pulling were applied simultaneously; that was perfectly natural. The duty of the shaft was really only the taking up and transmitting of the turning moment produced by the piston. In the case of engines that work with reciprocating pistons the motion had to be transformed into a rotary one; the shaft was drawn this way and that, with the result that it was subjected to friction and driven out of its proper position. In this respect the large steam engine was not so unfavourably situated; the bearings were placed at a considerable distance apart. In the large oil engine, however, the bearings were near together, and when wear did take place, the shaft was subject to great stresses even in case of small degrees of displacement. If the question were then asked, what was the most perfect form of shaft, the answer must be—That which is grasped at as many points as possible. The rod arrangement thus unquestionably represented a long step forward.

H.R.H. the Grand Duke of Oldenburg said the prevailing opinion was that the oil motor was the engine of the future! The greater then was the value of the paper, and the thanks of the meeting were due to Professor Junkers for having made public his laborious work in such an unselfish manner.

After a very brief discussion on Herr Josse's paper, a *précis* of which appeared in our last issue, Herr Direktor Walter's paper, entitled "The Turning of a Twin-screw Steamer in her own Length as Affected by the Direction of Rotation of the Screws," was taken. Distinguishing between right-handed screws, which turned clockwise, and left-handed ones, which turned in the opposite direction, the author drew attention to experiences which the Norddeutscher Lloyd had had with twin-screw vessels with both kinds of propeller arrangement. The captain of the small twin-screw steamer Vorwärts having repeatedly complained that his vessel could not be relied upon to turn in her own length in a desired direction, an investigation into the causes of this had showed it to be due to the "inward" rotation of the screws, the port screw being right-handed and the starboard screw left-handed. During the turning manœuvre the propellers rotated in the one case both in the right-handed and in the other both in the left-handed direction, the water being in the former case heaped against the vessel's side by the advancing, and drawn away by the backing propeller, while in the latter case the process was reversed. This told against the inwards rotating propellers; but it was further found that the lower propeller blades were doing more work than the upper ones in each case, and that the horizontal resultant pressure tended to drive the stern round to starboard in the case of right-handed, and to port in the case of left-handed rotation. The inwards-turning propellers were, thus during the manœuvre in question, exerting lateral forces tending to turn the vessel in a direction opposite to that of the couple formed by the ahead and astern thrusts acting with the leverage formed by the distance between lines of shafting at the thrust blocks, which is usually relied on. In the case of the outwards-turning propellers the lateral forces at the stern assisted the couple instead of resisting it. The Vorwärts, an alteration of which was then decided upon, had a length of 205ft. 4½in., a breadth of 31ft. 2in., and a depth moulded of 12ft. 10¾in. With an indicated horse-power of about 1000, she had a speed of 12 knots, and her two-bladed, inwards-turning screws of 8ft. 4½in. in diameter and 11ft. 9½in. pitch ran at 135 revolutions per minute. The propellers and cranks were interchanged and made to rotate outwards instead of inwards, with the result that the vessel turned in a satisfactory manner. At the suggestion of the captain, the unnecessarily cut away dead wood was replaced, in order that, in the turning manœuvre, the vessel might have the advantage of the action of the water thrown by the inwards-rotating screw against the hull. Here again an advantage was attained, the vessel making a complete turn in about 3¼ min. instead of in about 4¼ min. Before the alteration, when the ship had no way on her, a turn to port had to be made with the port screw alone going ahead, the rudder at the same time being turned hard a-port. For a turn to starboard a corresponding manœuvre was made with the starboard screw turning (ahead) and the rudder a-starboard. The vessel did not, of course, turn in her own length, but moved ahead. She then had to back and repeat the process once or twice till the turn was accomplished.

As a result of these experiences the small T.S.S. Gazelle was altered in the same manner with excellent results. The speed of the vessel was not impaired in either case. It was thought that the steering of a vessel in motion was less affected by the direction of rotation of the propellers, because the forward movement of the wake gave the upper blade relatively more work than the lower one, so that the total loads on these were more nearly alike. With screws and rudder deeply immersed the effect of the direction of throw of the screws was not nearly so marked.

Opening the discussion, the President, Geheimrat Busley, said, with reference to his treatment of the same problem in his well-known work, that at the time it was written only the experiments with the Sachsen were available. This vessel had had inward turning propellers and a large turning circle, and her commander held the opinion that an interchange of the propellers would improve the steering. The propellers were interchanged, but the engine, being of the trunk type, would not run backwards at full speed because of the pressure on the trunk stuffing-box. The results of trials showed, however, that with outward turning propellers the manœuvring of the vessel was improved.

Geheimer Regierungsrat Prof. Flamm said he could not in every point agree with the explanation given by Direktor Walter. He held the opinion, which was also confirmed by the results of laboratory experiments, that it was perhaps more correct to say that when the propellers were not too deeply immersed the inward turning arrangement would be less efficient because air would be sucked in. In the course of 4000 experiments made with self-propelled tugs in a canal it had been found that with inward turning propellers the engines had to make 15 revolutions more to maintain the ship's speed. With regard to the cause of the bad steering qualities, he observed that the photographs of propellers working in the absence of motion ahead did not show the phenomena when the motion had assumed a condition of constancy. At the moment of starting the propeller sucked in a large quantity of air; a heaping of the water against the side of the vessel then took place, but only at the moment of starting. After a condition of permanency had become established the scattering action ceased, the mound disappeared, and there was no throwing of the water against the side of the vessel, but a tendency towards a lowering of the surface level then showed itself. He did not, however, take the view held by Dr. Ahlborn. There was no eddy ring, the appearance of the latter being probably due to the circumstance that this experimenter had his propeller working against a pane of glass; he could not account for it in any other way. In the course of the many experiments made by himself, he had not once seen the eddy ring. There was present at the outset a greater efficiency in an outward turning propeller, and the less efficient of the two propellers during a turn was the inward turning one. The phenomenon in the case of the Leopard of the Austrian navy was probably to be explained by the deeply immersed position of the propeller, because the entrance of air into the space about it was, at the low speed of rotation in question, hardly likely to have taken place.

Herr Rosenberg wished, in connection with the paper, to give some experiences with regard to right and left-hand turning propellers; they confirmed what Direktor Walter had told them. A new ferry, built by Tecklenborg, had been started between Bremerhaven-Geestemünde on the one side and Nordenham on the other. The vessel had a length of 164ft. (50 m.), a breadth of 28ft. 4½in. (8.65 m.), and a draught of 5ft. 9in. (1.75 m.); she had very fine lines, and had a displacement of only 500 tons. In view of the shortness of the distance the vessel was provided with a continuous shaft, one propeller forward and one aft. Her speed was 11 knots. She had right-hand turning screws with 3ft. 3½in. (1 m.) tip immersion. Viewed in the direction of advance, the vessel always had to come with her right-hand side to the quay. In the case of sternward motion of the propellers, the right-handed propeller had to turn in the left-handed direction, the water to flow in that of the current of the river, and the vessel itself to lie at the land side. But the vessel came to the quay very badly, and the captain wanted left-handed screws. At first it had been thought that the captain was wedded to old usage, but in the end a pair of left-handed propellers exactly similar in pattern to the first pair was fitted, and the manœuvre of coming to the quay at once became easier. This confirmed what Direktor Walter had said.

Professor Ahlborn said he would like to correct some of the statements made by Professor Flamm. Professor Flamm was of opinion that the eddy ring in his (the speaker's) experiments was due to the presence of a glass plate. This was a mistake. The eddy ring had made its appearance in every case, and if Professor Flamm had failed to make it visible, the reason was that he had not introduced any visible suspended matter into the water. That was how the eddy ring had escaped him. He was of opinion that great caution must be exercised in the forming of conclusions from the phenomena arising from the introduction of air into the space about the propeller, because the air would exercise a detrimental influence. He thought it preferable to introduce foreign matter of the same specific gravity as the water, as he had done in his own experiments.

Herr Kempf wished, in connection with the subject under consideration, to give the results of some experiments which he had made in Uebigau. He had arranged in front of a propeller a series of chemically prepared nets and introduced a chemical substance into the space about the propeller. The object in view was the determination of the path of the chemically treated particles of water. Where these passed through one of the wire nets a dark spot was produced, and a series of such spots lay in a curve, the run of which could be determined by measurement. It could be observed that the path of a particle was subject to a central prolongation, and that a radial suction took place on all sides. By means of this direction of flow the action of the propeller was clearly observable, and by this practical result the solution of the propeller problem was brought considerably nearer.

After Direktor Walter had replied briefly, and had received the usual vote of thanks, Dr. Wagner's paper on "Practical Results with Counter Propellers," was taken. Reviewing the attempts hitherto made to "turbinise" the screw propeller, the lecturer showed that with efficiencies of 65 to 75 per cent. the propellers hitherto constructed still fell far short of the 80 to 85 per cent. efficiency of high-class water turbines. With the fixed counter propeller set behind the ordinary rotating one a turbine effect was produced, which utilised the energy delivered to the screw shaft to the extent of 85 to 87 per cent., while a further improvement which might bring this up to 90 per cent. was anticipated. A wire model showed the torsional flow of the water from the ordinary propeller. The blades of the counter propeller had somewhat the section of a very shallow spoon, into the hollow of which the water was delivered at an angle with the axis of motion, to be then deflected aft. The counter propeller blades were so set that a certain forward component of the diagonally delivered stroke of the main propeller resulted. The effect of the main propeller also was increased. The counter blades thus differed from those of Parsons, which were also illustrated. The casing which had been used in connection with a turbine propeller by Thornycroft could be dispensed with. The counter propeller, which had already been fitted to thirteen motor boats and small vessels and to one turbine torpedo boat with good results, had so far been applied with about six blades, two or more of these, as the case might be, being prolonged, so that their ends could be attached to the hull of the vessel. Curves taken from progressive speed trials made with five of these vessels all bore much the same character. A slight loss at very slow speed changed to a substantial gain at the cruising, and a still greater one at the maximum speed. The revolutions made by the propeller were meanwhile reduced in number, showing that, with a smaller propeller, a further improvement might be expected. In the case of new vessels this would, of course, be attended to. The tendency of vessels of high speed in proportion to their length to settle by the stern was, with the counter propeller, reduced in some cases by one-third. The vibrations set up by the propeller were, in cases in which the latter was fairly immersed, considerably reduced, as was shown by diagrams taken with and without the appliance. To the steering of the vessels the counter propeller was in some cases slightly detrimental, but it was thought that a suitable alteration of the rudder would remedy this. The same applied to the case of going astern, in which an unsuitable rudder likewise played a part. For single-screw vessels it was recommended that the rudder be made somewhat larger, and, if possible, be of the "balanced" description. In the case of some motor boats at the Monaco contests it was found that pitching and rolling were somewhat reduced when the counter propeller was fitted. During the runs with the torpedo boat the blades of the counter propeller became pitted and suffered other damage, this being attributed to removable causes, including the application of an unsuitable method of casting. With regard to expense, it was estimated that a counter propeller fitted to a completed vessel might cost from one and a-quarter to at most twice as much as the main propeller. In the case of a vessel designed for it the extra cost was considerably less than this. A calculation based on the increased efficiency obtained in the experimental installations showed that the application of the appliance to all the vessels of the German mercantile fleets would in five years produce a saving of about 1¾ million pounds. For canal work it was shown that the counter propeller reduced the erosion of the bottom and banks and increased the towage efficiency. Experiments with air vessels showed that when both propellers had as many blades as practicable a higher efficiency was attained. For an eight-bladed main propeller combined with a thirty-bladed counter propeller the efficiency was increased by about 10 per cent.

The discussion was opened by Professor Flamm, who thought the results obtained with the counter propeller

* No. I. appeared December 1.

merited very favourable recognition. Thus, if disturbances of other kinds did not make their appearance, the counter propeller would produce an advantage, especially for canal navigation where the bottom of the waterway was lined with waterproof material that had to be preserved from damage. If the motion of the water were controlled and directed aft, the damage to the bottom would be prevented. He would like, therefore, to see more experiments made. It would interest him very much to know the respective efficiencies for two-bladed and for eight-bladed propellers in combination with counter propellers.

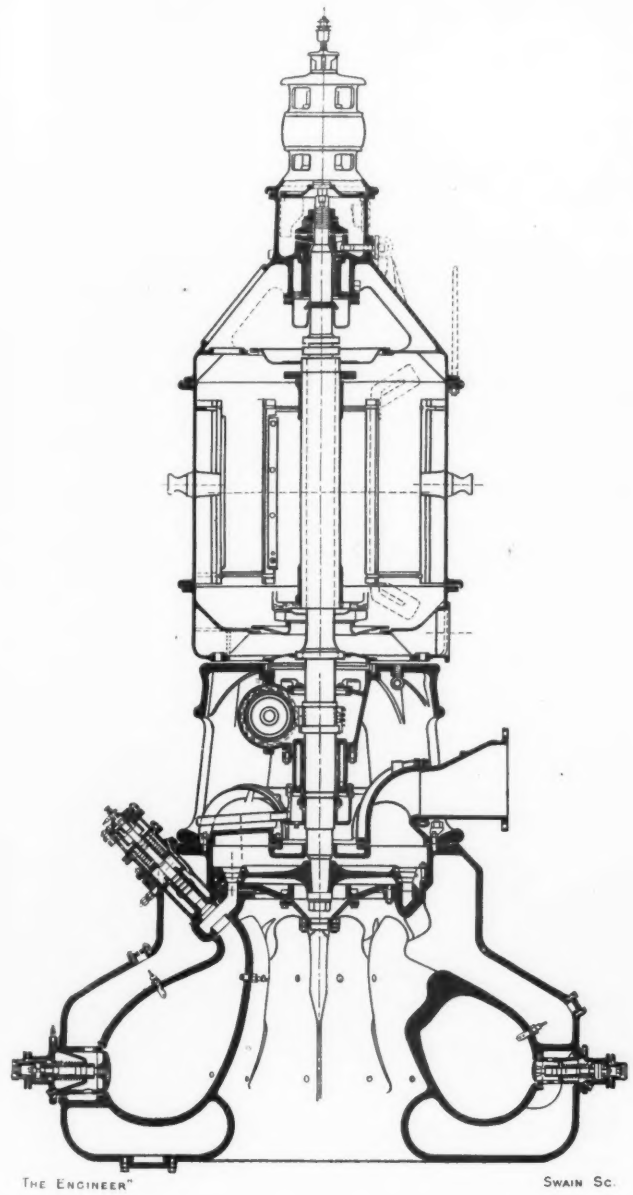
Herr Bauer said he had had many opportunities of experimenting with small vessels, and had paid special attention to the question of the disturbances produced by floating objects which got into the counter propellers. They had made drastic experiments, and had often scraped over the ground at very low water, and had, after many unsuccessful attempts, at last—in one single case—brought about an accident. They had gone at full speed over the ground, the propeller making a very high number of revolutions; one of the counter propeller blades was somewhat bent, and the tip of one of the blades of the main propeller was knocked off; the counter propeller itself was not further damaged; the result, thus, was that damage of considerable severity had not caused any general interruption in the working of the engines. It had, moreover, been found that the counter propeller damped the pitching motions of a vessel very considerably. He had experienced this in the Mediterranean, and had made parallel experiments without the counter propeller. Further, he had heard from various quarters that the sea qualities in the case of a following sea were very much improved, and the settling down aft had, especially in torpedo boats, been reduced. An important advance was the possibility of the application of an engine with a higher speed of revolution, which was brought about by this counter propeller, because, although the efficiency of the main engine decreased as the number of revolutions increased, this was more than made good again, and a gain was obtained because the whole engine became cheaper.

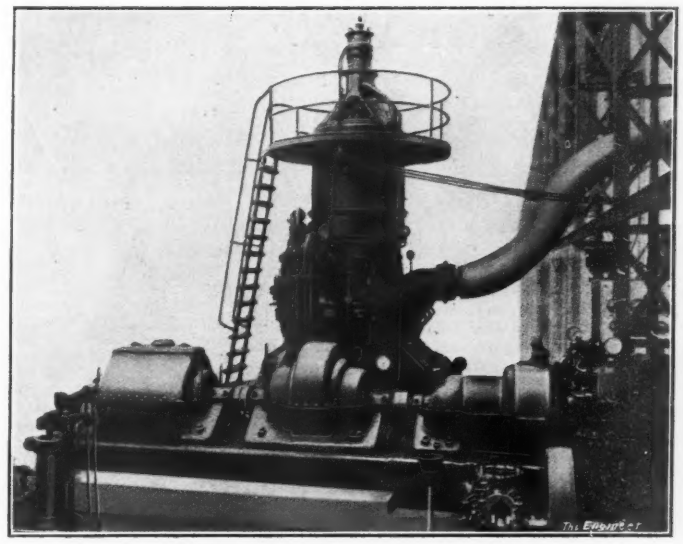
Dr. Bendemann said he only wished to make a few remarks on the advantage of the application of the counter propeller to air propellers. He had made many experiments with air propellers, and in the course of these had also had the idea of making practical use of the rotation component. The counter propeller was of the greater advantage the less the efficiency of the main propeller. The two-bladed propeller which the author had used had an efficiency of only .43, and when a four-bladed propeller was applied the result had been still poorer. He would like, therefore, to see further experiments made with counter propellers, and must meanwhile express a doubt whether eight-bladed propellers would ever be used in practice.

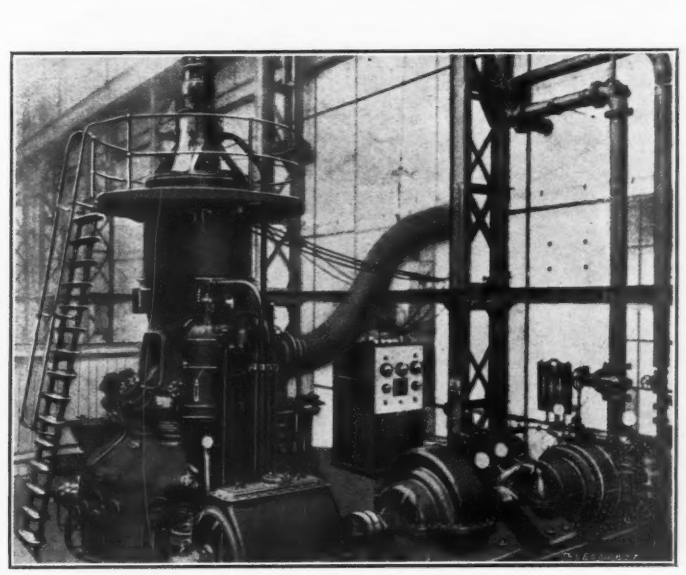
Herr Eggers referred to the troubles likely to ensue from the counter propeller getting fouled by hawsers, &c., and said the big companies could not accept it on account of that risk.

Dr. Wagner, in reply, said he had asked himself the same question, whether foreign bodies would not foul the propeller, and, apart from experience on actual service, during which nothing had happened, he had made experiments, and for three hours at a stretch he had kept throwing small lumps of wood into the water. The space interval between propeller and counter propeller had been only .08in., but no mishap had occurred. Even if a counter propeller were to become slightly damaged, the consequences would still not be so very grave; he believed Herr Eggers erred on the side of caution, which, indeed, in the interests of a shipowning firm, was very intelligible; the risk, however, was not, for instance, to be compared to that in the case of the thousands and thousands of blades in the steam turbine. He would certainly not have put forward the counter propeller if only 2 to 3 per cent. greater efficiency had been obtained with it, but when the improvement amounted to from 10 to 15 per cent. it was in the interests of every shipowning firm that studied economy to avail itself of this advantage. If an efficient main propeller were combined with a counter propeller an improvement would always result, and it would be productive of great advantage if such experiments were made. He would be very glad if the idea thus brought before the meeting should be further taken up, and the immense advantage to German shipping which it represented should be made the most of.

Then followed Herr H. Holzwarth's paper on "The Gas Turbine." After briefly sketching the process applied in the gas turbine, in which, he said, a mixture of gaseous fuel and air or of fluid fuel and air was caused to burn and the energy inherent in it set free in such a manner that the gaseous product of combustion became subject to the highest possible pressure, the excess of the latter over the atmosphere being then made use of in the turbine proper, the author drew a comparison between this motor and the engine and boiler of the steam turbine installation. Under the highest combustion pressure the gas-air mixture was, in the Lemale gas turbine, introduced into the combustion chamber and there continuously burnt. The outlet from the chamber took the form of a nozzle, through which the product passed at high velocity, to be then used in driving the turbine. The combustion chamber thereby became very hot and had to be cooled by enclosure in what was practically a steam boiler. The other possible solution of the problem—that of the explosion turbine—had been adopted in the Holzwarth-Junghans turbine. A sketch of a 1000 horse-power suction-gas turbine was given. The arrangement took somewhat the form of a lantern-like tower about 10ft. in diameter by 21ft. in height, with a broad base containing the combustion, air and gas chambers with their appurtenances. These were in several sets in the round, each with a nozzle at the top through which the product of combustion passed to the horizontally rotating turbine wheel and thence to the exhaust. Above the ring of exhaust outlets was arranged the dynamo with its central vertical shaft hung from the top and passing through the turbine cover without a stuffing-box. The chambers belonging to the explosion process were of ellipsoid or similar form, so as to be able to withstand the pressures on the least possible weights of material. The weight of these chambers was given as about 17 tons and that of the gas turbine at about 25 tons, an equivalent reciprocating gas engine without fly-wheel being referred to as weighing about 140 tons. The valve arrangement was worked by pressure oil instead of by mechanical means as in the reciprocating engine, a horizontal shaft in the tower section below the dynamo actuating the appliances which distributed the pressure oil at the right times to the various valves. Sketches of a horizontal plant of the same power were also shown, and general plans of an actual installation including it, which is being constructed by Messrs. Brown, Boveri and Co., of Mannheim. Experiments with different gases showed that, to ensure ignition at proper and regular intervals, the temperature of the exhaust chamber had to be varied. For petroleum, gas oil, and coal-tar, the suitable temperatures were 400 deg., 440 deg., and 375 deg. Cent. respectively. Further, the correct fashioning and dimensioning of the nozzles was found to be of the

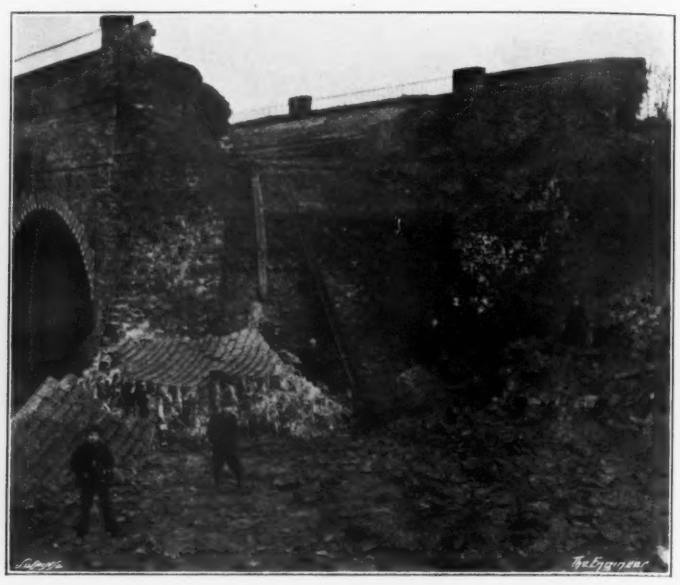






1000 HORSE-POWER HOLZWARTH GAS TURBINE

COLLAPSE OF THE AIRE AND CALDER NAVIGATION NEAR BARNSLEY



highest importance to the smooth working and efficiency of the motor. From Herr Holzwarth's book we take the accompanying illustrations and supplementary notes.

The turbine can be constructed in either a vertical or horizontal form, but the first machine—illustrated herewith—is vertical. The pear-shaped gas chambers are below, forming a base, which carries the dynamo, &c. The turbine wheel is keyed to the end of the shaft, which is carried entirely from above. A horizontal shaft driven by spiral gearing from the main shaft operates the governor, the safety gear, which controls the ignition, the tachometer, the ignition gear, and a valve, which controls the supply of oil which operates the valve gear. All the valves are placed on the explosion chambers, which, it will be observed, are arranged in a ring. The air and gas valve is placed at the lower end of each chamber, whilst at the upper end is a valve operated by pressure oil, which closes the passage to the jet during the entrance of the explosive mixture. The air and gas are maintained at a small pressure in the spaces surrounding the explosion chambers, but are kept apart. The section shows on the left side an air valve, and on the right a gas valve. The former, it will be seen, opens to the upper part, and the latter to the lower part of the external casing. Both valves are controlled by oil pistons. The cycle is as follows:—A mixture being in any one chamber is fired electrically, and the pressure created lifts the nozzle valve and permits the gases to impinge on the turbine wheel. As the pressure falls the valve closes under the influence of the spring, but controlled by the oil cylinder. Before complete closure air is admitted, expelling the burnt products and partly cooling the wheel. When the valve is closed gas in the proper quantity is admitted, and the cycle is repeated. The turbine illustrated develops about 1000 horse-power at 3000 revolutions, and was made by Brown, Boveri and Co.

Professor Krainer said he should like to put only one question to the author. It was well known that extensive experiments had been made during the preceding year with the gas turbine, and that certain noteworthy results had been obtained. Now he would like to know of what material the blades were made for these high temperatures, and further, what efficiencies were obtained and how the blades were attached.

Herr Holzwarth said the question with regard to the material of the blades and the experiences obtained with them was very easy to answer. In the case of the first turbine they had formed the blades out of the disc itself. The material was nickel steel. They had observed no pitting. Subsequently they had used ordinary steel, and that for the blades was made by electrolytic means, *i.e.*, it was electro steel. They had gone up to temperatures of 500 deg. Like Messrs. Brown Boveri they had attached the blades with a dovetail arrangement, and they had found that after a considerable term of service they had not become loose.

The last paper on the list, by Herr Fr. Lux, on a "New Electric Torsion Indicator," elicited no discussion. The paper contained the description of a shaft torsion measuring appliance, which was claimed to represent an improvement on the indicators hitherto in use for this purpose. By means of an electric apparatus it was rendered possible either to make observation of the angle of twist or to obtain a record on a revolving drum. The arrangement was such that the turning moments and the horse-power hours could be directly read off.

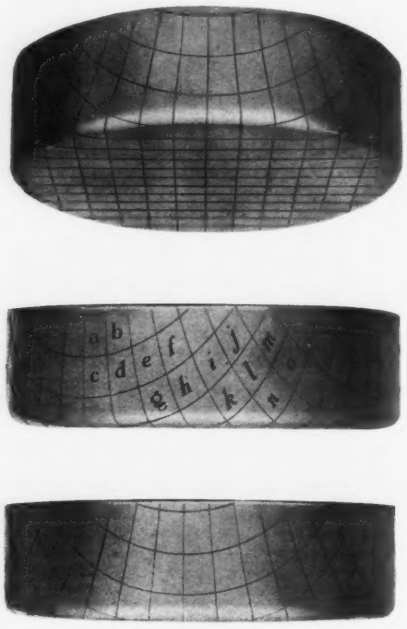
COLLAPSE OF A CANAL EMBANKMENT.

ON Monday morning, November 20th, a serious slip occurred in the embankment of the Aire and Calder Navigation, close to the point where it joins the Dearne and Dove Canal at Barnsley. The latter canal runs at this place in an easterly direction parallel to the river Dearne and about 50ft. above it. The Aire and Calder Canal, approaching from the north, crosses the narrow valley of the river by a stone aqueduct of five arches. It was at the back of the south-west wing wall of this aqueduct that the water was observed to be leaking through the embankment at 5.30 a.m. By 6 a.m. the breach had widened to 6ft., and ultimately 100ft. of one side of the embankment, including the wing wall, were carried away. Fortunately, the canals were dammed before the whole of the embankment was washed out; as it was, about 40ft. of the towing path which lies on the eastern side of the canal and the fence wall alongside had been scoured away by the rush of the escaping water. Otherwise the structure of the aqueduct appears to have escaped damage. The section of the canal at this point was about 20ft. wide and 7ft. deep. The quantity of *débris*, containing a large proportion of road material, amounts to about 7000 cubic yards, and lies spread over a large area, a considerable portion having been washed down into the river Dearne. The two engravings show very clearly the extent of the damage.

PRESSING SHEET METAL.

IN connection with the discussion of a paper, "Pressed Steel for Automobile Construction," read some time ago by Mr. L. A. Legros before the Institution of Automobile Engineers, Mr. Henry Lea has communicated to the "Proceedings" the result of an interesting test on the raising of a pan from a circular blank of tinned steel. The particulars of Mr. Lea's test are herewith reproduced for the benefit of our readers.

The blank used was initially 9½in. in diameter, and



STAMPED METAL PAN

0.012in. in thickness. The diameter of the pan formed from this blank was 6¼in., its depth 1⅝in., and the radius of the corners ¼in. Before the blank was pressed it was marked on one side with ¼in. squares. A study of these squares after the raising of the pan shows something of the behaviour of the metal while being pressed. In the first place it is to be noticed that the periphery of the blank was 9.5π in. in length, and that the rim of the pan was 6.5π in. Hence the periphery of the disc had been compressed in the ratio of 3:9.5, or 31.6 per cent. Again, a diameter of the blank measured 9.5in., while the length revealed by a central section of the pan was (1.5 + 0.39 + 6 + 0.39 + 1.5), or 9.78. The diameter of the blank had therefore been stretched 3 per cent. This stretch, however, took place solely in the sides of the pan, and not in the bottom. Hence the stretch of the metal forming the sides and the radius at the foot was 8 per cent. A distorted square at the rim was found to have been reduced in width from 0.5in. to 0.33in., or a reduction of 34 per cent. This compares with the 31.6 per cent. mentioned above. The depth of the distorted square was found to be 0.62in. as compared with 0.5in. before distortion. This is an increase of 24 per cent. Thus at the rim the extension suffered was 24 per cent., while over the whole sides and corners it was only 8 per cent., as stated above. The squares on the bottom of the pan suffered no distortion.

By developing the curved surface of the pan side it has been found, by using a planimeter, that the areas in square inches of the distorted squares lettered in the accompanying engraving were as follows:—$a = 0.230$, $b = 0.217$, $c = 0.250$, $d = 0.247$, $e = 0.243$, $f = 0.240$, $g = 0.253$, $h = 0.250$, $i = 0.240$, $j = 0.207$, $k = 0.250$, $l = 0.245$, $m = 0.225$, $n = 0.255$, $o = 0.237$. It will be seen that the maximum increase in area is only 2 per cent., but that the maximum decrease, occurring in the square j, is 17 per cent. This is accounted for by the slight wrinkling which takes place round the rim of the pan.

THE CARE OF STEAM BOILERS.

THERE has just been issued from the Home-office a "Memorandum on Steam Boilers," prepared by Mr. William Buchan, one of his Majesty's Inspectors of Factories. This report has been prepared for the guidance of steam boiler users and those in charge, and contains a large amount of information on the causes and prevention of explosions and accidents.

The memorandum opens with some general remarks on the Boiler Explosions Acts, and then passes on to consider the principal causes of explosions. Under such headings as internal corrosion, grooving, overheating, water hammer, &c., we find the common sources of danger lucidly explained, and the proper precautions to take in each case clearly indicated. The next section of the report deals with dangers peculiar to particular types of land boilers. The egg-ended boiler, the Cornish and Lancashire boilers, the dry-back, vertical, hay-stack and rastrick boiler are each in turn discussed and their peculiar features of danger pointed out. Locomotive and water-tube boilers are also dealt with in this section. Dangers peculiar to boiler mountings, &c., are next considered. Stop valves, isolating valves, reducing valves, steam pipes and steam traps, steam separators, safety valves, pressure gauges, water gauges, low water alarms, fusible plugs, feeding arrangements, injectors, blow-off cocks, manholes and mudholes are all dealt with.

The definition of the term "boiler" as used in the Acts is wide. Hence the report includes a discussion of the dangers peculiar to certain steam-using appliances, which, although not commonly regarded as boilers, are grouped with such for the purposes of the Acts. Among these we may mention economisers, superheaters, bakers' steam ovens and hot plates, calendering machines in laundries, humidifiers as used in textile factories and drying cylinders in bleachworks, paper mills, &c. The whole memorandum is excellently illustrated, and forms in every way an admirable production. It should be in the hands of all who are or may be responsible for the care, management, and construction of steam boilers.

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETING.—At the students' meeting, held at the Institution on Friday, the 1st December, at 8 p.m., Messrs. J. and W. Legg read a paper entitled "Brake Lining Coefficients of Friction." The chair was taken by the President, Dr. W. C. Unwin, F.R.S. The paper gave detailed results of the authors' experiments on the relative value of several brake lining materials, and the variation of the coefficient of friction between cast iron and the material, with the intensity of pressure and the relative velocity of the two substances. The results obtained were illustrated by numerous lantern slides and diagrams. The discussion was opened by Mr. T. J. Taplin, and was continued by Messrs. R. W. Brims, C. T. B. Donkin, G. A. Clark, H. V. Hatt, and—at the President's request—Professor E. Wilson.

RAILWAY MATTERS.

A FEW years ago the North-Eastern Railway Company instituted a road service for the transport of farm produce and heavy goods from Tollerton and Brandsby. This service has given such an impetus to the trade of the locality that the company intends to apply to the Light Railway Commissioners at their next session for sanction to allow it to construct a light railway from Haxby to Brandsby, a distance of ten miles.

IT is reported in the *Electric Railway Journal* that the Chicago Railways Company has just placed an order for 1569 coasting clocks, with the Railway Improvement Company of New York. The Chicago Railways Company has been conducting quite an elaborate test with coasting clocks, and has had on its cars fifty of these coasting clocks which it purchased some time ago. The result of this test has evidently been satisfactory to the company.

THE short section of the Sunning Railway between Kung-yik and Tow-shan, China, which was opened to traffic last year, has proved profitable, and its extension to Sunwui, whence it would have water connection with Hongkong, is expected in the near future. The earnings of the railway have averaged about £2000 a month. The road was built with funds three-fourths of which were raised by Chinese from the Sunning district living in California, and the remainder locally. All of its cars and most of its locomotives were made in the United States. The promoter of the railway was a Chinese who had spent many years in America.

FIVE patents recently issued to H. Ward Leonard relate to electric motor control, and are notable for the early date of application and the breadth of claims. The principal patent of the group is based on an application filed in 1901. The other applications were filed in 1905 and 1906. There are eighty-eight claims in the patent based on the earliest application, and sixty-two, thirty, eighty-eight, and 111 claims respectively in the other four. The patents include broad claims on regenerative methods, especially for alternating currents, on single-phase traction, and on multiple locomotive control, also on various systems of voltage speed control.

THE Swedish section of the railway from Kiruna to Narvik is to be electrified, and it is intended to obtain the electrical energy by the harnessing of the Porjus Waterfalls. According to the *Iron and Coal Trades Review*, the Swedish Riksdag has now voted the necessary funds for the project, which, apart from the electrification of the line between Kiruna and the Norwegian frontier and the erection of the power plant, also comprises the building of a new railway between the Porjus Falls and Gellivara. The work, including the erection of the electrical power station and the harnessing of the falls themselves, has already been started. The estimated cost of the project amounts to about £1,200,000, and the sum of £222,222, to be expended in 1912, has been voted by the Riksdag.

IT is reported in the *Electrician* that the City Council of Montreal has recently taken steps to abolish the smoke nuisance in that city. With this end in view the railway commissioners have been asked to pass a rule requiring the railway companies to adopt some one of four methods of preventing smoke. One of the four is the use of electric locomotives in the city. The railways have already been considering the matter of electrification of their Montreal terminals, but the Canadian Pacific and Grand Trunk Railroads came to the decision to do nothing, at least for the present. The Canadian Northern Railway, on the other hand, has been considering the extension of its line to a central position for a city terminal. The adoption of electricity as the motive power on this extension is very probable.

THE Canton-Hongkong Railway is now in full operation for passenger and freight service. It was formally opened on October 4th. The first or British section was constructed from Hongkong to Sam Chun, about 22 miles, and opened about a year ago. The second section was constructed by the Chinese Government, with the money loaned by the Colonial Government of Hongkong, and extends 89 miles from the British border at Sam Chun to Canton. The British section tunnelled through many mountains, and cost £1,032,942, while the Chinese section, traversing level ground, and having two main bridges, cost £1,302,000. Two through express trains are run in each direction daily between Canton and Hongkong. Nearly all the freight cars and passenger cars were made in China.

THE new trans-Australian railway scheme which has been passed by the Commonwealth Parliament will be commenced without delay, and within a period of probably three years it will be possible to travel by train from Perth, in Western Australia, through South Australia, Victoria, New South Wales, to Queensland, a distance of some 4000 miles. The line will run a considerable distance inland, and not skirting the coast. The line starts from Kalgoorlie, 380 miles from Perth, one of the eastern limits of the West Australian system, and runs to Port Augusta, the most westerly part of the South Australian system, whence it connects with other railways. The new line is 1060 miles in length, and will be of a 4ft. 8½in. gauge. This will necessitate considerable expenditure on the part of the Western and South Australian and Victorian Governments, whose gauges are 3ft. 6in. and 5ft. 3in. The line presents no engineering difficulties, and its total cost is estimated at £3,650,000.

ACCORDING to the *Electrician*, the most recent developments in the electric locomotives for passenger service on the New York, New Haven, and Hartford Railway are represented by seventeen additional engines that have been recently ordered. This latest type of single-phase locomotive is equipped with four driving axles, as was the original design; but the new engine has eight motors, instead of four, two motors being geared to a quill surrounding each axle. This equipment, which at first appears more complicated, is in reality lighter and cheaper than a locomotive of the same size having four motors of the same total capacity. This type permits the use of small motors for locomotives of large capacity, and the matter of repairs is greatly simplified. Each of the small motors has practically one-half the number of brushes, brush-holders, and field coils, as are used in one large motor, so that there is the same total number of these parts on the locomotive as on one equipped with large motors. Both motor pinions drive the same gear, which permits the use of only one gear on the quill, while the large motor requires twin gears.

IT has become necessary, in order to prolong the life of certain of the bogie tramcars on the London County Council's system, to make arrangements for them to be trussed in a more substantial manner than that adopted when they were manufactured. The question of trussing tramcars has always been difficult, and car manufacturers and tramway authorities have been carrying out experiments in this connection for many years. In 1907 a new system of trussing was introduced into the Council's specification for the supply of tramcar bodies; 875 cars built in accordance with this new system of trussing have been delivered up to the present time, and very satisfactory results have been obtained from them. In view of these results, the Highways Committee consider it desirable that, as far as practicable, the bogie cars built before 1907 should be trussed in a like manner, by fitting them with deep rolled trussing plates, similar to and practically interchangeable with those used in building cars of the present standard type. This work, it is pointed out, can be most conveniently carried out by the staff of the tramways department when the annual overhaul and renovation of each car is dealt with. By proceeding in this manner approximately 50 cars a year can be dealt with under the present conditions at an average cost of about £31 a car.

NOTES AND MEMORANDA.

EXPERIMENTS recorded in *Nature* of November 23rd indicate that the light emitted by fireflies possesses some of the properties of the X-rays and ultra-violet light, producing strong effects upon photographic plates through media opaque to light, but not through glass.

THE longest concrete floor in the world is probably that of the recently completed Armour-Swift-Burlington Bridge across the Missouri River at Kansas City. This bridge is of unusual interest, as it is the longest riveted truss in the world. The contractors, by careful planning, were able to mix all the concrete with one mixer, which was stationed on the shore, with an extensive hoisting tower adjacent.

FOREIGN patents are being applied for by Herr Ingeniör Chr. Oftedahl, of Christiania, for a chemical process whereby he claims that iron and steel plates may become hardened and unpierceable, while at the same time maintaining their normal elasticity, and without being fractured by blows or collision. The inventor, who has devoted several years to the preliminary stages of this discovery, maintains that the chemical substance can be added during the actual process of rolling. Experiments are contemplated at the mills of a large foreign works, and if, as is anticipated, these will be successful, the result will be of immense importance to many branches of the iron and steel industry, and especially in connection with shipbuilding material.

A POINT relating to the earthing difficulty which is sometimes overlooked is that it is hard to get a good earth connection in some mines. There may be an earth connection to-day, and it may be gone in a week hence. It is in connection with this question of earthing that the armoured cable system comes in, and with the new protective devices the armouring affords an extremely easy medium for earthing. It is also much cheaper, as the armour provides a good conducting path. The armouring, however, should consist of a layer or layers of galvanised steel wires, and not of steel tapes, as it gives greater flexibility, and the conductivity of wire armour is about ten times better than that of a tape armour.

TESTS are to be made by the Panama Canal Commission to determine the value of cement mortar, applied to iron plates by the "cement gun," as a preservative. According to the *Iron and Coal Trades Review*, twelve plates, 63in. by 14in., have been coated with a 1 to 3 mortar of cement and sand, after being cleaned to grey metal by the sand-blast process. Six of these have been covered with ¼in. coating, and the remaining six with a 1in. coat on one side and a 1¼in. coat on the other. Three plates of each kind will be kept immersed in salt water to test the mortar method of preventing corrosion. Two plates of each kind will be taken from the salt-water bath at the end of three months, and one half of the coating will be removed to determine the condition of the metal. The duration of the test for the balance of the plates will be determined later.

THE potassium photo-electric cell is extremely sensitive to light, and is being used by Professor Rosing for experiments in television in place of selenium, its resistance when it is illuminated falling, owing to the emission of electrons by the potassium cathode. It has recently been used for measuring the luminosity of terrestrial bodies, there being a direct relation between the resistance and the intensity of light falling upon it. Some important work has been done recently by Geitel and Elster in increasing its sensitiveness, this having been accomplished by passing an electric current for a short time through the tube. The tube containing the potassium is filled with hydrogen, and the effect of the current is to cover the potassium with a greenish film, which parts with electrons very readily under the influence of light. This film and the extra sensitiveness due to it are not permanent, but permanence has now been obtained by replacing the hydrogen, after the formation of the film, with argon.

THE direct-current balancer is either a dynamotor having one armature with two similar windings and two commutators, or a motor generator consisting of two similar machines coupled together. Theoretically the permissible output of such a machine is the rating of one winding, but practically the armature drop and brush contacts have to be taken into account. The brush contact effect is often serious. Improvement of the brush contact sometimes restores a lack of voltage balance of 2 or 3 per cent. In some cases the three-wire machine is preferable to either of the above. It consists of a single or polyphase rotary converter, the collector rings of which are connected with the terminals of a booster balance coil, the neutral being taken from the common centre. The mechanical advantages of the three-wire balancer over the two-machine balancer are:—One commutator instead of two, reduction of brush contact trouble, two bearings instead of three or four, compact structure, and absence of torque in shaft or couplings.

AT a recent meeting of the Institute of Marine Engineers a paper on "Steam Turbine Theory" was read by Mr. F. J. Kean, B.Sc. In the course of his paper the author said that the most convenient way to measure the energy liberated in a turbine in thermal heat units was to use the temperature entropy diagram. In the ideal case of the Rankine Clausius cycle the expansion was perfectly adiabatic; no heat was being taken in or given out, the entropy remained the same. In an actual steam engine there was loss by condensation and radiation from the cylinder walls, while in the case of a steam turbine of the Parsons type, the energy wasted in steam friction returned to the steam and more than counterbalanced the radiation losses. The speed of the steam in that turbine was never less than 100ft. per second, and often reached 500ft. per second, so that even with well-formed blading the surface friction must be considerable. The secret of power in expansive working was to cause the steam to give up its heat; the wetter the steam at exhaust the more efficient the turbine, provided the dryness fraction at exhaust was not less than the adiabatic value.

AT the recent annual meeting of the American Gas Institute three papers were submitted on "The Manufacture and Sale of Sulphate of Ammonia." The manufacture of sulphate of ammonia, it was stated, might be said to have begun on a moderately large scale in America in 1893 with the erection of by-product coke oven plants. Before this sulphate was made at various gasworks and elsewhere; but the plants were necessarily of small capacity, as the supply of ammonia was limited to the works' output. These conditions had in great measure been changed. A number of by-product coke oven plants had been built, many of which were successfully converting their ammonia into sulphate. The usual recovery of sulphate from coal was about 1 per cent. of the weight of the bulk used; so that for the production of 5 tons of sulphate per day 500 tons of coal must be carbonised. There were but few coal-gas plants of this daily capacity in the United States; but, on the other hand, most of the by-product oven plants exceeded it. It was pointed out that the United States was now third among the nations of the world producing, or rather recovering, ammonia from coal; and though the output was not as yet one-third that of England or Germany, the potential production was nearly as great as that of both of those countries together. About 74 per cent. of the estimated production of sulphate of ammonia in the United States last year came from by-product coke ovens, and the prospects were that any considerable increase in the production of the country would be from that source. Reasoning from what had been done, and considering the direction in which new construction was being planned, the conclusion was arrived at that the centre of by-product production, and therefore of sulphate recovery, would be in the vicinity of Chicago.

MISCELLANEA.

THE Secretary for the American navy, in his annua report, recommends the building of two battleships annually, a policy which will eventually, though not as soon as desired, give a total of forty battleships. This is considered to be the minimum strength necessary to maintain the position of the United States as a world power, notwithstanding the fact that two powers have more ambitious building programmes.

THE British Consul for Lombardy, reporting upon the trade of his district in 1910, states that during the year twenty-one new electric companies were formed, with a share capital of £560,000, two of them with capitals of £120,000 and £80,000 respectively, while thirty-two existing companies increased their capital. Only four companies went into liquidation, and four others reduced their capital, but the companies which dissolved or liquidated were taken over or joined others. On the whole, an additional sum of £2,000,000 was invested in electrical industries. Of the 118 companies engaged in these industries, fifty paid no dividends, but they were mostly of recent formation.

ALTHOUGH not one of the chief mineral products of New South Wales, platinum is found in paying quantities. According to the *Chemical Trades Journal* it has been mined in the central portion of the State and the beach sands on the north coast have been treated for it. Up to the end of 1909 the total Commonwealth production was only 11,578 oz., valued at £20,000, and nearly the whole of it was contributed by New South Wales. Last year 332 oz., valued at £1380, were won there. For some years the price of the metal abroad has been rising, until at the end of June, 1911, it had attained the record of £8 per ounce. This high price will probably lead prospectors in New South Wales to investigate more carefully the possibilities of platinum mining.

ACCORDING to *Eastern Engineering*, screws are still made in India just as they were made originally, by winding two soft wires together around a mandril. The wires are then carefully separated, and one of them is soldered into a tube or nut, while the other is soldered to a short rod. All the silversmiths make their screws in this way, and they are all left-handed, for they are wound over and over by the right hand. Screw bolts and screw presses were introduced by Europeans, and for many years all the cotton exported from India was compressed by a massive screw of wood, turned round by cattle yoked to a long lever. This screw may still be found in remote districts. It is cut entirely by hand, and is set out by winding two ropes around the hand-dressed beam to give the pitch. The nuts are cut in halves. These screws, 14in. in diameter, do very good work, and if properly oiled last well.

"ELECTRIC Clocks" was the title of a paper read before the students of the Scottish Local Section of the Institution of Electrical Engineers on Friday, November 17th, by Professor Magnus Maclean. The author mentioned that electric clocks ware first produced about the middle of last century, since when hundreds of patents had been obtained, most of which employed faulty mechanical gear, operated electrically, and consequently resulted in failure. Detailed descriptions were given of the three chief systems in successful use, consisting of independent clocks wound up electrically; a number of independent clocks synchronised electrically by a master clock every hour; a number of clock dials controlled and impelled by a master clock at regular intervals. Professor Maclean suggested a further method whereby a single master clock would synchronise every hour a certain number of independent clocks at different parts of the city, each of which would control and impel 200 or more dials in blocks of buildings in the neighbourhood.

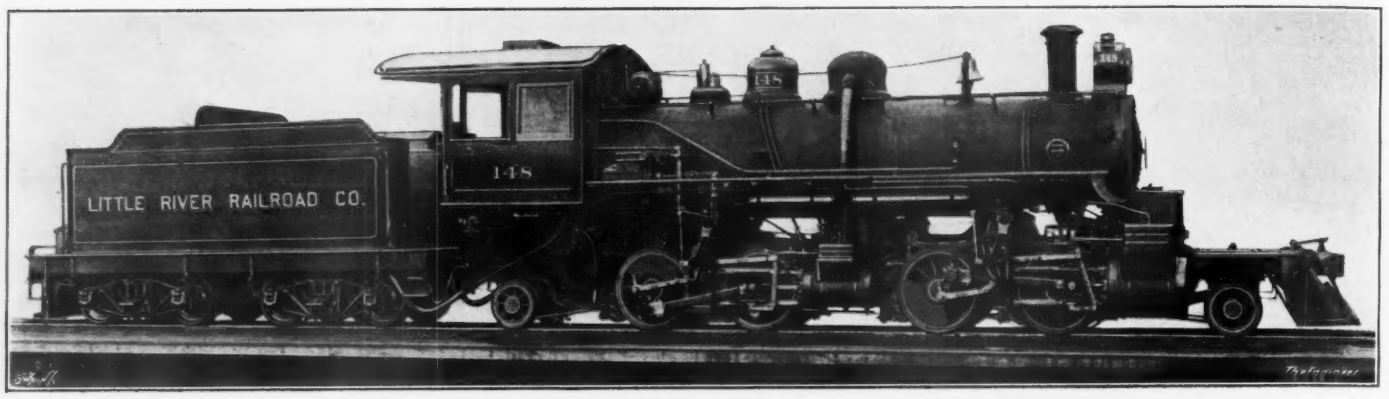
AMONG the many useful minerals recently discovered in the vicinity of Richmond, Vancouver, were vast deposits of diatomaceous earth, which have so far not been utilised. The chief use of this earth is for cleaning and polishing, either in the form of powder or mixed with soap. It is an effective non-conductor of heat, and has been used alone or with various compounds for coverings for boilers, steam-pipes, and safes, and in fireproof cement. Its great absorbent qualities fit it admirably for use in water filters and for dynamite. For the latter use it is mixed with wood pulp. It is used largely by paint manufacturers as a wood filler. Boiled with shellac it is made into records for talking machines. In Germany it has been used for the absorption of liquid manures, so that they could be utilised as fertilisers, as a source of silica in making water glass, in the manufacture of cement, tile glazing, artificial stone, ultramarine and other pigments of aniline and alizarine colours, paper filling, sealing wax, fireworks, hard rubber objects, matches, and papier-mâché, for solidifying bromine, and for many other purposes. The value runs from £1 4s. to £1 16s. a ton.

THE development of dynamite as a farm necessity in America, and the education of the farmers to an appreciation of its value in facilitating their work and improving the quality and the quantity of their products, has been most interesting. Although the attention of farmers has but recently been directed to its use for various agricultural purposes, experiments have been going on for many years to determine the exact efficiency and how it can best be used. Some years ago it was thought that the only use of explosives on the farm was for splitting up stumps so that they could be dug out more easily. Later it was discovered that the cheapest and quickest way of getting rid of stumps of any size was to lift them out completely from the ground and reduce them to fire-wood size at one operation. About the same time it was decided by many enterprising farmers that it was good business policy to blast out boulders and plant the ground they occupied rather than plough around them. Blasting out cellars was the next step, which in turn led to the idea of blasting the rock encountered in digging drains. Soon after ditches were being created in a flash, through practically any kind of soil. Fruit growers began preparing their orchards with light charges of dynamite; and by breaking up hard-pan and other impervious soils, thousands of acres of land that were previously worthless have been made to bear phenomenal crops.

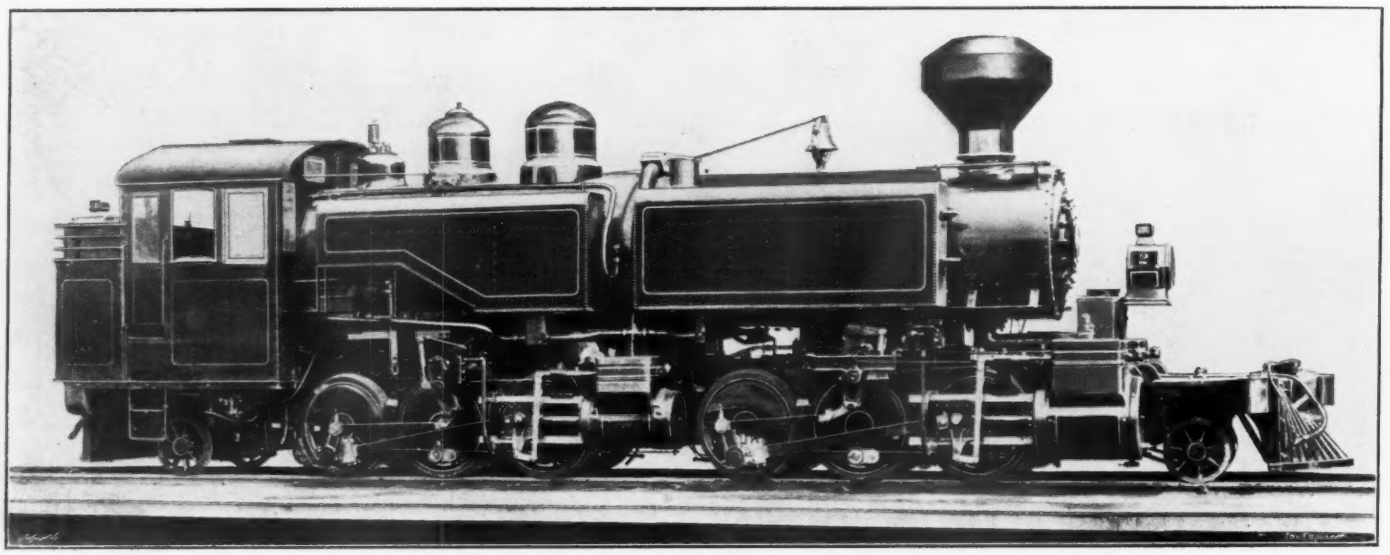
SOME details of the equipment of the new Kussara power-station of the Bombay Tramways and Electric Supply Company are given in the *Electrical Review*. The site has a frontage to the harbour and connects with the railway. It will allow of extensions up to 50,000-kilowatts total capacity. The present boiler plant is provided with bunkers, having a capacity of 2500 tons, with a conveyor system connecting to a coal-crushing plant and receiving hoppers at ground level. The ashes are taken by a basement railway to elevators delivering to railway trucks. Sixteen Babcock boilers and four economisers are erected. The generating plant consists of a 2000-kilowatt turbo-generator, and two 1000-kilowatt engines and generators newly erected; also the following sets at Wari Bunder are being, or have been, transferred to the new building:—One 500-kilowatt and two 1000-kilowatt turbo-generators, one 1000-kilowatt, one 300-kilowatt, and two 500-kilowatt reciprocating engines and generators, giving an initial capacity of 8800 kilowatts. Provision has been made for the installation of three 700-kilowatt exhaust steam turbo-generators in connection with the 1000-kilowatt reciprocating sets. The whole of this plant generates three-phase current at a pressure of 5500 volts between phases. For condensing purposes the water of the Kussara Basin is drawn on, and the latter has been deepened so as to form a permanent reservoir of about 5,000,000 gallons. The larger units and groups of high-tension feeders are provided with remote control switchgear, and the switches generally are installed on galleries along one side of the engine-room.

MALLET LOCOMOTIVES ON AMERICAN RAILWAYS

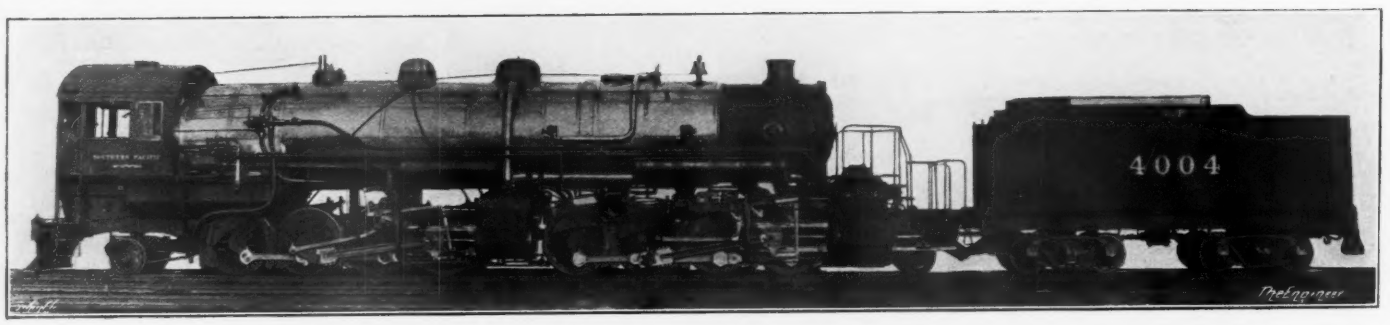
(For description see page 83)



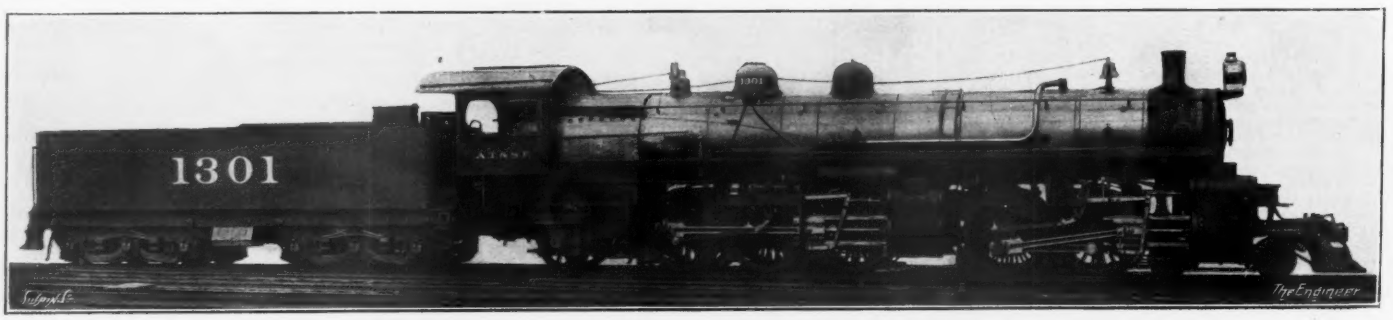
63-TON MALLET LOCOMOTIVE, LITTLE RIVER RAILROAD COMPANY



MALLET TANK ENGINE BELONGING TO THE BOOTH KELLY LUMBER COMPANY



MALLET LOCOMOTIVE WITH CAB IN FRONT, SOUTHERN PACIFIC RAILWAY



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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other Letters to be addressed to the Editor of THE ENGINEER.

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*** *With this week's number is issued, as a Supplement, a Two-page Engraving of the Miles Glacier Bridge over the Copper River, Alaska. Every copy as issued by the Publisher includes a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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DEATH.

On November 27th, suddenly, CHARLES EDWARD HALL, Mining and Mechanical Engineer, of Town Hall Chambers, 87, Fargate, and 443, Langsett-road, Sheffield, in his 66th year.

THE ENGINEER.

DECEMBER 8, 1911.

Naval Power in South America.

IN naval matters the attention of the people of this country has been so taken up with the relative positions of England and Germany in warship construction that the progress of other navies and the possibilities of their influence on the international equilibrium have been to some extent lost sight of. It is, of course, impossible to foresee with any degree of certainty the future course of events with respect to those delicate questions which always arise when nations are growing on the one hand, and when, on the other hand, older established nations are seeking new markets for their productions. We do know, however, from experience that wherever there are competing nations in a foreign market all sorts of difficulties are bound to arise, and a determining factor in their solution is the power behind the respective nations with which they can enforce their demands or maintain their position. Hardly less in importance is the naval and military strength of the Power to which the market belongs, if this Power is of sufficient magnitude to alter the balance appreciably.

The naval situation in South America is one of exceptional interest for this country in view of the large amount of English capital invested in the several republics, and the enormous market they afford for British produce. Other powers, notably Germany and the United States, which already have a considerable share in South American business, are looking for a still larger proportion. English notions of fair play do not ask for more than a fair field and no favour, and the position is one full of interest for the capitalist, the investor, and the general observer. The former may shrug his shoulders, and shake a warning finger when Brazil, Argentina, or Chile want money to buy Dreadnoughts; the investor may be scared as to the security of his income, but the general observer, with no money to lend and no dividends to draw, will see only a sign of the times. The fact is that the desire of the three chief South American Republics to increase their navies is the natural outcome of a national spirit, which has always been strong, and which we should be the last to decry. It may be true that these countries are spending more on their military strength than is justified by their resources, but here again we should not hurl the stones of criticism, having regard to the vitreous nature of our own house. These countries are young, and in youth zeal often outruns discretion, especially in the matter of income and expenditure. It may also be true that there is great waste and corruption in the administration of public money for the navies of these nations except possibly in Chile, where, under the able direction of a very strong man with an irreproachable character, the tone has been enormously raised. In respect of administration we have our own dark page in the past, as readers of the diary of Samuel Pepys will remember. The nations which progress realise, often only after bitter experience, that clean and efficient administration of public affairs is a *sine quâ non.* Patriotism must eliminate peculation or the nation will go under. There are not wanting signs that the three great republics of South America, Argentine, Brazil, and Chile are learning the lesson, and the development of their natural resources, coupled with the growth of the national spirit, must eventually, and probably at no distant date, make the naval power of these countries a factor of importance in international affairs. The more northern of the South American republics are not so far advanced, and are not at present factors of any importance. Actually, at the present moment, the three powers, sometimes appropiately referred to as the A, B, C of South America, have under construction or in project eight Dreadnoughts between them, as well as considerable torpedo fleets, which, given efficient handling, should prove sufficient to prevent active interference from foreign powers. There are many thinking men in these countries who realise that it is not differences among themselves which have to be feared, but rather the growing tendency of the United States to extend the Monroe doctrine to include everybody and everything in North or South America—a tendency which the opening of the Panama Canal will certainly not diminish. While the United States are entitled to a just reward for their enterprise and capital expended on the completion of the Canal, the long-standing interests of other nations must be respected, and if this policy conflicts with the elastic nature of the Monroe doctrine, so much the worse for that doctrine, which appears, like charity, to cover a multitude of diplomatic sins. It is hardly likely, either, that the growing national spirit to which we have already referred will tamely permit outside interference in matters which concern only the South American republics, and we can only applaud this attitude, which is what we ourselves should adopt in like situation, and in so far as the navies of of Argentine, Brazil, and Chile help to sustain this self-respect we must commend their resolution, even though on the face of it the possession of a powerful navy on the part of either of them appears an expensive luxury. With the modern material which these countries have at their disposal the value of their navies will depend upon the training and discipline of the *personnel.* In this respect the navy of Brazil has yet a great deal to learn, as is evident from recent events in that country; the discipline and organisation is somewhat better in Argentina, but Chile, in spite of her smaller size and less wealth, stands an easy first for naval efficiency. In this supremacy national character and environment play an important part. Chile has an enormous sea coast compared with the total area of the country, much more in proportion than either Brazil or the Argentine, and as a consequence her population is much more maritime in character than that of the other two. Brazil has the disadvantage also of being entirely within the tropics, a geographical fact which militates against the training of the seaman. It requires familiarity with the stormy seas, which as a rule are not found in the tropics, to give that confidence which is requisite to the handling of ships and that hardihood which is part of the true seaman's being. The southern part of Chile, where for the best part of a year it blows a gale, affords a training ground that probably has no equal in any part of the world for the making of seamen, and, as is well known, no Chilian naval officer is promoted unless he has served a proportion of his time in these waters. The other factor in Chilian naval superiority is the system of training, which is modelled on English lines, and is carried out as far as possible in the English way, with a result that is open for the world to see. Brazil and the Argentine have nevertheless great opportunities. They have great resources and increasing population. British enterprise and capital, largely in engineering works, such as docks, harbours, and railways, have done much towards the prosperity of these countries, and the patriotism of their peoples looks ahead to still further development carried out by themselves for themselves.

It will be probably many years before this dream is realised to the extent of being able to do without foreign capital, but the spirit is undoubtedly there, and hence the fixed determination of these nations to maintain navies adequate to protect their integrity. With this spirit as basis great results are possible, but their patriotism must take practical shape in the rooting out of all forms of insubordination and corruption, the existence of which makes the attainment of naval efficiency impossible.

Electrical Manufacturing in Germany.

THE continued prosperity indicated by the recently published annual reports or balance-sheets of the principal German companies which are engaged in the manufacture of electrical machinery, plant, and accessories, suggests that the scheme of co-operation in the British electrical industry which has now been brought into existence has not been advanced at too early a period. A great deal of the lack of prosperity in the United Kingdom, according to the chairman of the British Electrical

and Allied Manufacturers' Association, is due to the position assumed by manufacturers themselves, as it is of no advantage to destroy one another by competition. This statement was made at the inaugural dinner of the Association, when the chairman added that, although reasonable rivalry in prices is required, there is greater need for competition in excellence. The lessons as to the effects of severe competition on the one hand, and of co-operation on the other, have already been learned and taken advantage of in Germany. Yet the operation of these two causes has not conferred a complete monopoly upon the three or four leading firms in that country. The idea of placing the electrical industry in the hands of a few huge establishments has prevailed for several years past, and it can scarcely be said to have been abandoned at the present time. It applies not only to the various branches of manufacturing, but also to contracts for works, factories, or dwelling-houses, which are to be equipped for lighting and power purposes, and for connection with the distributing mains of central or sub-stations. But one Federal Government after another is now intervening with the object of preventing the establishment of a monopoly in the contracting branch in connection with the numerous overland or cross-country stations which have been built, or are in contemplation, for the supply of many country localities extending over large areas in different parts of the country. Although the few large companies provide occupation for the majority of the total number of electrical workers, there are still several hundreds of smaller and small firms of makers and contractors who give employment to 70,000 workers, and who are now fighting for their existence in rivalry with the large works.

The various amalgamations of manufacturing works in recent years only represent one of the causes which have contributed towards the development of the few large works, although it is doubtless the principal reason, taken in conjunction with the extensive financial support which is regularly rendered by the several banks which are interested in these undertakings, and which frequently have their own delegates on the board of directors of the electrical companies. Another cause is to be found in the system of co-operation adopted in undertaking enterprises of considerable extent both at home and abroad, whilst at the same time mutual working has also prevailed, and is probably still exercised through the respective branches with regard to general contracts, and even in respect of comparatively insignificant transactions of the value of one thousand pounds. How the system of co-operation in the matter of small contracts was worked was shown by the revelations which were made three years ago in respect of the so-called secret syndicate in the German electrical industry, the object of which was to regulate prices so as to exclude the possibility of outside competitors being successful. Whether the syndicate still exists is problematical, but the publication of its guiding rules caused it to be deprived of a large amount of its power. On the her hand, the keen competition for contracts of inconsiderable value has proved to be disastrous to a number of small firms of makers, to say nothing of contractors. But the advent of overland or cross-country generating stations a few years ago opened up the prospect of securing a monopoly not only of the generating machinery and plant, but also of the supply of motors and accessories and installation materials, and the work of erection, &c., for the customers of these stations. Alarmed at this fresh attempt on the part of the large works to extend their partial monopoly, the Association of Special Electrotechnical Works applied to the Governments to intervene in the matter, so as to prevent the large firms from concluding agreements with the local authorities, who are mostly the owners or joint owners of the overland stations, which would exclude other firms from participating in contracts outside of those for generating station or substation plants and mains. As a consequence the Prussian Government issued an order in August, 1910, instructing the Government officials to refuse to sanction any agreements between firms and local authorities which would confer on the central station contractors a monopoly for installation plant and materials, and since then similar orders have been made by the Governments of Baden, Alsace-Lorraine, Brunswick, and Reuss.

The resistance offered by the smaller manufacturing works in Germany to the advance of the larger establishments does not appear to have checked the development of the latter in any way during the twelve months ended with June, 1911. This is scarcely surprising, in view of the highly prosperous condition of the manufacturing industry when regarded from the standpoint of the amount of employment, whilst prices, although not yet satisfactory, are showing a tendency to improve slightly at the present moment. One firm, for instance—the A. E. G.—has just declared a dividend for 1910-11 at the rate of 14 per cent. on an ordinary share capital of £6,500,000, or the same rate as was paid on £5,000,000 in the preceding year. The company's turnover amounted to £15,300,000, as compared with £12,600,000 in 1909-10, and the orders on hand on September 30th, 1911, represented a value of £18,100,000, as contrasted with £13,500,000 on the corresponding date in 1910. These figures were given by the chairman at the annual meeting held recently, when it was also stated that the various works are at present employed to the maximum of their capacity, and a further increase in the turnover can only be expected when the extensions of works now in progress are completed. It is impossible for the moment to cite similar details regarding the other two large works, as their respective reports have not yet been issued for 1910-11, although the general financial results have just been announced. The Siemens-Schuckert Works records much larger net profits than in 1909-10, and proposes to pay 10 per cent. on the share capital of £4,500,000, being the same rate as in the previous year. An increase in the net profits is also announced by the Siemens and Halske Company, and the dividend remains at 12 per cent., as in 1909-10, on a share capital of £3,150,000; whilst the improvement in the working results of the Schuckert Electricity Company, which is now chiefly an investment company, is shown by an advance in the rate of dividend from 7 per cent. in 1909-10 to 7½ per cent. in the past financial year. The figures tell their own tale, and if personal considerations were not opposed to further concentration it is possible that the three largest firms would be formed into an electrical trust.

The Next Move.

THE position in which the four railway unions find themselves at the moment is vastly interesting. About a month ago the officials called for a ballot of all members on two questions—first, would they accept the report of the Royal Commissioners; and, secondly, would they be prepared to strike for recognition and the all grades programme? The ballot has been going on ever since, and ended only yesterday. In the meantime came the debate in the House of Commons, when the unions failed to find justification of their repudiation of the report, and were practically forced by Mr. Lloyd George's resolution to endorse it. On no other grounds than complete acceptance of the report by both sides would the Government take any steps to bring the parties together, and when they had been brought together it was understood that the only matters to be discussed between them were to be the best means of putting the recommendations of the Commission into operation. Now, observe what has happened. On the very day appointed by the Board of Trade for the first meeting between the companies and the unions—a meeting which in itself is a tacit acknowledgment of the report—the results of the balloting are counted and the executives of the unions are informed that the majority is opposed to the acceptance of the report, and is prepared to lay down its tools and fight for recognition and the all grades programme! The position of the leaders is unenviable, either they must emulate the robber captain and "follow" their men, as most labour leaders now-a-days do, or they must keep their faith with the Government. If they do the latter their own people will rise against them, if the former all hope of Government help is lost. Needless to say, we desire to see them, and we believe we shall see them, true to the Commission. It is probable that they will declare the voting in favour of war not sufficiently preponderant, and will discuss the Commissioners' report with the companies in the spirit of the agreement. On the other hand, if the voting overmasters them they must at once recall their ambassadors. That they would even then venture on a strike we do not believe. To have the remotest chance of success the strike would have to be fought by a united body of men supported by public sympathy. We know that the men are not united, and we cannot doubt that the public would only be irritated by the rejection of the good offices of the Government. The unions position, then, is too weak for them to try a fall at the present time. The companies, on the contrary, are very strongly placed. They have done all that the Government has asked and are assured of its help, they have made preparations for a struggle, they may count on the support of a great number of their men, and the public is wholly with them.

Naval Architects.

WE conclude to-day a compulsorily brief report of the meetings of the Schiffbautechnischen Gesellschaft, a body which holds in Germany a position similar to the Institution of Naval Architects in this country. We say compulsorily brief because it is no fault of ours that the subjects cannot be dealt with at greater length. The Schiffbautechnischen Gesellschaft, unlike our own Institute, binds its proceedings and sells them to the general public, and for that reason it refuses to permit any of its illustrations to be reproduced, or anything like a full translation to be given of its papers. Whether it is wise in following this course, at least in the case of foreign journals, may be open to doubt, but it is clearly a matter on which the Institute alone has the right to decide. Restricted as our reports are, we do not hesitate to say that they may be read with exceptional interest by Englishmen and Americans. The German Institution, whilst it is a cousin to our own and the American Institute of Naval Architects, differs from them in a way which gives food for thought. We are accustomed to regard the German as a rather metaphysical, precise, and mathematical person. We expect, and as a rule we do find, a great deal of attention paid to minute thoroughness very frequently about matters of no real consequence. But at the meetings of the Schiffbautechnische Gesellschaft there seems to be a different atmosphere. There is, to begin with, a general feeling that all are working with the single object of increasing the power and prestige of German maritime commerce and German shipbuilding. Such a spirit is rarely displayed at our own meetings, and did it appear it would not improbably be regarded as out of place at a meeting of scientists. Furthermore, the Teutonic and the Anglo-Saxon minds seem to have changed places. At the German meetings, under the influence of the feeling to which we have just alluded, everything is utilitarian, whilst at our own there has always been a tendency, only checked with difficulty of late years, to hand the meetings over to professors and theorists, who cover the walls, the boards, and the papers with diagrams and mathematics, and empty the hall of all save a few who are there for lack of any other employment, or because someone must support the authors and speakers. Take, for example, the different treatment that has been accorded to the screw propeller in the German and the British institutions. Here we have such a theoretical paper as that which Dr. Froude gave us this spring, whilst there the subject is being investigated by the elaborate experiments of Dr. Flamm and others. Or, again, consider the treatment of the old question of inward and outward turning screws, or the use of a counter propeller. They are both subjects which our own Institute has not neglected, but they have scarcely ever been attacked with the same resolve to turn them to practical account. Of course, we could name dozens of papers of the highest practical value which may be found in the proceedings of the Institution of Naval Architects, but they do not seem to be so frequent as with the Schiffbautechnische Gesellschaft. If we take the titles of papers alone there is not much to choose, but it is in the treatment of the subject that the difference is seen. That the Institution of Naval Architects is far better than it was a few years ago no one will deny, but that it still fails to hold the practical shipbuilder is made clear by the poor attendance which some papers secure. If that Institute were fired by an enthusiasm to keep its nation's shipbuilding and British marine commerce always in the first place, as the German Institute is, we should find a more lively interest in its proceedings. The theory of the universality of science is sublime, but it is not commerce, and in such matters as shipbuilding, science that is not utilitarian is of little use.

THE SMITHFIELD CLUB SHOW.

THE engineering exhibits at the Smithfield Club Show, which was opened at the Agricultural Hall, Islington, on Monday, December 4th, and which remained open until this evening, are well up to the usual standard, and all the leading agricultural engineers are represented. During the past few years there has been a steady increase in the number of firms showing oil motors for agriculture and transport, whilst steam ploughing and other engines fitted with superheaters have also become more and more prominent. This year

Petters Limited, of Nautilus Works, Yeovil, exhibit a spring-mounted oil traction engine. The Petter 1911 tractor is intended for hauling loads of from 8 to 10 tons, but much heavier weights can be drawn over good roads and where there are no steep gradients. It will draw and operate a thrashing machine, saw bench, or other machine in the same manner as a steam traction engine. It is also suitable, when provided with specially wide travelling wheels, for ploughing and cultivating and for all classes of agricultural machines which can be drawn behind a tractor. The engine is a specially designed Petter oil engine of 30 brake horse-power, suitable for working with ordinary petroleum or crude oil. The

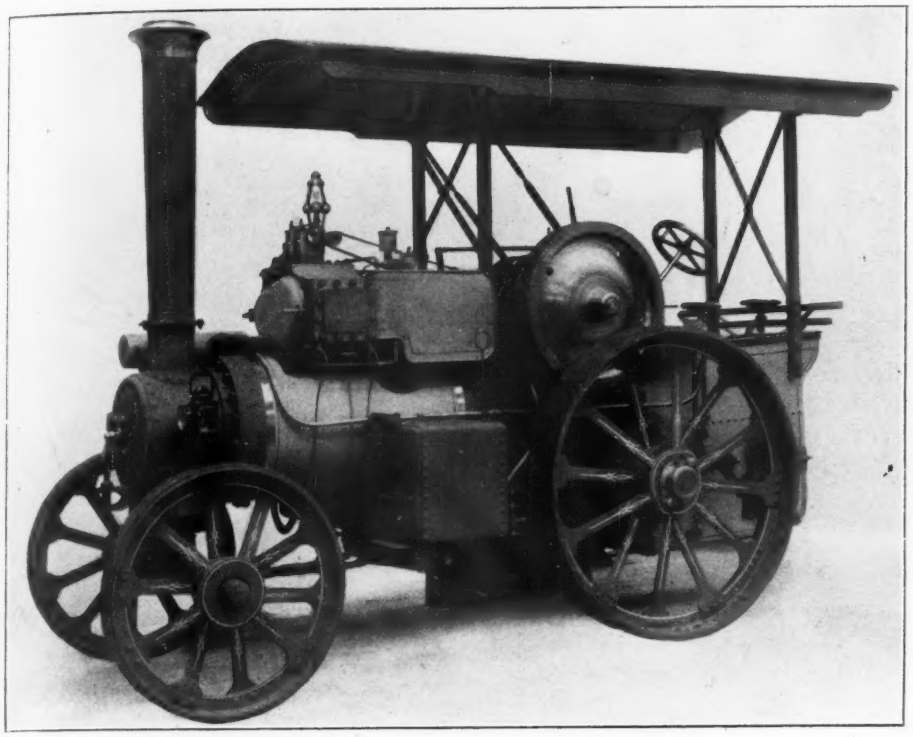


Fig. 1—MARSHALL COMPOUND STEAM TRACTOR

balanced crank shaft is enclosed in a dust-proof casing. The transmission gearing is controlled by a friction clutch capable of transmitting more than three times the engine power. Two forward speeds can be obtained and also a reverse motion. The final transmission from the intermediate shaft to the rear axle is by a Renold chain. The travelling wheels, axles, compensating gearing, and steering arrangements are all designed on the lines of steam practice. For stationary work the engine is provided with a driving pulley 28in. in diameter. The power of the 1911 Petter tractor is approximately equivalent to that of a 6 nominal horse-power steam traction engine, but the engine is considerably lighter and more power is therefore available for actual tractive work. We are told that the tractor is capable of hauling a gross load of 8 tons up an incline of 1 in 10. It is fully equal to hauling and operating the ordinary thrashing machine. The consumption of fuel naturally depends on the class of work being performed, but will usually average on the road about a gallon and a half per hour.

Marshall, Sons and Co., Limited, of Britannia Ironworks, Gainsborough, exhibit a new steam tractor, a traction engine, a portable engine, a thrashing machine, a patented fire-box, and various accessories. The steam tractor, which is shown in Fig. 1, is of the compound type, and works at a pressure of 200 lb. per square inch. It has a fire-box of the Belpaire pattern, a tubular feed-water heater, a double "pop" safety valve, and an adjustable crosshead. Special attention has been paid to the lubricating arrangements, the gearing running in an oil bath. An oil pump is provided for the cylinder lubrication. Machine cut gearing is fitted to give speeds of 2½ and 5 miles per hour. Four-pinion compensating gear is employed to facilitate turning sharp corners, and to relieve the gearing of undue stresses. The tractor is well suited for all classes of haulage work, as well as for driving machinery through the medium of a belt. It can also be adapted for direct-traction ploughing. Further, by the provision of roller wheels and under gear the tractor can readily be converted into a road roller of six or eight tons weight. A 7 horse-power single-cylinder traction engine is also shown on the stand. A short inspection of this engine is sufficient to show that every care and forethought have been given to the design. The engine is fitted with a special design of adjustable crosshead, a four-pinion compensating gear, to facilitate turning at sharp corners, gearing for speeds of two and four miles per hour, mechanical equipment for cylinder lubrication, a water lifter with suction hose and rose, an injector, and a winding drum carrying 50 yards of wire rope. A portable engine also shown is designed for six nominal horse-power, and works at a pressure of 120 lb. per square inch. A mechanically operated oil pump provides a supply of oil to all the working parts. The crosshead is provided with circular bored guides, and variable expansion and reversing gear is fitted. One of the most striking features is the fire-box, which is rectangular in shape, and on the top has corrugations which are arranged to form an exceptionally strong truss to the crown plate. The design is such as to facilitate the cleaning of the top. Several other advantages, such as slightly increased heating surface, better circulation, reliability, and fuel economy, are also claimed. A fire-box of this type is shown separately. A thrashing machine is also exhibited. This is a large-size machine with a 22in. diameter drum. It is fitted with chaff cleansing and sacking apparatus. The portable engine and thrashing machine are very similar to those shown this year at the Turin International Exhibition.

It is scarcely necessary to say that the firm of John Fowler and Co., Limited, of Leeds, is in evidence. The exhibits include steam cultivating tackle, road locomotives, &c. A 10 nominal horse-power compound ploughing engine is shown for working on the double engine system of steam cultivation. It is fitted with high-speed governors, and epuilibrum throttle valve, &c. The engine is suitable for thrashing, sawing, pumping, and other operations. Four hundred and fifty yards of Fowler's steel wire rope are carried on the winding drum. It will be remembered that in our article on last year's show we described the firm's steam ploughing engine fitted with its patented superheater. We are now informed that several of these engines are at work in this country, and that arrangements can be made to enable those interested in the use of superheated steam to inspect them. The firm's patented superheaters are also fitted to road locomotives when desired. Two of the firm's latest double crank compound road locomotives are on view; one is a 6 nominal horse-power engine, which has been built for a firm in Kent. The working pressure is 180 lb. In the case of emergency high-pressure steam can be admitted to the low-pressure steam chest by means of a starting valve which closes automatically. The engine is fitted with the firm's third-speed road gear, safety clutch gear, and also Fowler's spring gear. The other engine of this class is of 10 nominal horse-power, and has been built to the order of a firm at Reading. This is the largest and most powerful engine which is permitted by Act of Parliament in this country. We should not omit to mention a 7 nominal horse-power single-cylinder agricultural traction engine which is also to be seen on this stand. This is the makers' latest type of agricultural engine. It is specially constructed to meet the requirements of farmers, thrashing contractors, and agriculturists generally. It is well adapted for such work as thrashing, pumping, chaff cutting, sawing, and for all other operations where the belt drive is employed. The engine is also suitable for light haulage work. Much might be written about this firm's exhibits, but such things as Fowler's single engine cable system of steam cultivation and so forth are known to our readers, and it would only be going over well covered ground to describe them. We should mention, however, that there is an assortment of working models comprising various cultivating implements, also samples of steel wire ropes for steam cultivation, &c., and models of Fowler's patented spring mounted traction engines.

The firm of Clayton and Shuttleworth, Limited, is showing one of its latest agricultural or general-purpose traction engines. This is a single-cylinder 7 nominal horse-power engine. It is provided with a new form of clutch gear. Another exhibit on this stand is a compound steam motor tractor, similar to that shown at the last Royal Show. The boiler is of the "Belpaire" type. It is to be mentioned that the speed pinions are enclosed in a gear-box, and run in oil, and the gearing is so arranged that the engine drives on both sides. The differential gear is worked from the footplate. Other points to which attention should be directed are that the springs are of the laminated type, and are attached to sliding bearings in the main axle brackets, the whole being fixed outside the horn plates. By this arrangement perfect balancing of the engine is claimed to be secured. The feed pump is gear-driven. One of the firm's finishing thrashing machines is also shown. There is also a new "Triumph" clover huller. This machine has been specially designed to thrash and finish all kinds of clover seed in the most efficient manner. The frame is of Clayton's patented trussed design. Ring oiling bearings are fitted to all the principal shafts. An important advantage is that the hulling drum can be taken out at either side of the machine instead of at the back, and it is driven by means of two long belts, thus avoiding the excessively short direct drive between the thrashing and hulling drums. An important result of the double belt arrangement is the marked decrease in power required for driving the huller. A chaff sifting and bagging apparatus is attached, but this is only supplied when required.

On the stand of Saunderson and Gifkins, of Elstow Works, Bedford, there is a good example of one of the firm's new agricultural tractors. This machine has many special features, one of the most notable being the provision of an electrical device which automatically stops the engine in the event of the lubricating oil running short. The tractor which is shown in Fig. 2 is intended for agriculture or transport. It is spring-mounted on four wheels, the rear propelling wheels being 5ft. in diameter and 12in. wide, whilst the front steering wheels are 3ft. in diameter and 6in. wide. The engine is of the four-cylinder, water-cooled type. The diameter of the cylinders is 6in., and

Fig. 2—SAUNDERSON AND GIFKINS' AGRICULTURAL TRACTOR

the stroke 8in. Three speeds can be obtained in both directions, *i.e.*, 2½, 3½, and 7 miles per hour. A device is provided for locking the differential gear from the driver's seat. The engine is fitted with a spray carburetter with a float controlled oil supply and a vaporiser heated by the exhaust from the engine, and is designed to work with petrol or paraffin oil. There are pipe connections between the carburetter and petrol and paraffin tanks, which admit of change of supply without interrupting the working of the engine. Some tests recently carried out on this engine by Mr. Worby Beaumont show that it is highly economical. The principal object of these

trials was the determination of the oil fuel consumption when working on land. The work performed by the motor consisted in hauling one of the firm's standard B Z four-furrow ploughs with a two-furrow plough of the same make coupled to it for the first two trials. The length of the field was 454 yards and the area ploughed was 3.08 acres. The first trial over one-third of this area was made with the engine running on "Shell" petrol, and with both ploughs in service cutting six furrows. The depth ploughed averaged 5¼in. The second trial was made under the same conditions as the first, but with the engine running on paraffin oil. We do not propose to go into all the details of these trials, but the following figures relating to the second test may prove of interest:—

Time per Acre, 34 minutes.

	s.	d.
Two men's wages at 11d. per hour	0	6
Oil fuel—2 gallons 5⅜ pints at 3½d. (in bulk)	0	9¾
Water used, 1½ gallons		—
Lubricating oil—¼ of a pint used per acre	0	2½
Petrol used for starting—1½ pints at 1s. per gallon ...	0	2
Total expenditure per acre	1	8

Wear and depreciation is a debatable point, but even if so high a figure as 33⅓ per cent. on the total value of the machine be allowed, the gross cost per acre would work out at about 3s. per acre. The total weight of earth moved was 794 tons, and, as stated above, the depth ploughed was 5¼in.

Ransome, Sims and Jefferies, Limited, show a 4 nominal nominal horse-power compound light tractor, mounted on springs and fitted with a winding drum, water lifter and hose, a geared feed pump, injectors, governors, and awning over the tender. There are also two traction engines, one of 6 nominal horse power, and the other of 7 nominal horse-power, on their stand. These are single-cylinder engines, and they are suitable for thrashing, sawing, steam cultivation, and general farm work. Another exhibit takes the form of a 7 nominal portable engine. There is also a finishing thrashing machine, a representative collection of ploughs, including small-holding ploughs, general purpose ploughs, steel-chill digging ploughs, and balance ploughs. There are also two cultivators, one with nine tines arranged to give as much clearance as possible, and the other an eleven tine machine which can easily be converted into a horse hoe or ridger. One of the firm's swath turners is also on view. Other exhibits take the form of a new potato digger and two "wedge" horse hoes.

On the stand of Mann's Patent Steam Cart and Wagon Company a prominent exhibit is an agricultural tractor. These engines are designed for farm and estate work, and are made in two types, one with the hind wheels close together between the frames, and the other with the wheels outside the frame. The advantages claimed for the former are that the weight of the engine is more evenly distributed over the ground, and the last narrow strip between the "lands" can be ploughed out without the driving wheels travelling over the newly-ploughed land, whereas the outside wheels must, in some cases, partly travel on the newly ploughed land, or the last finishing strip may have to be ploughed with horses. The advantages of the outside wheel type are a slightly lighter engine for the same power, more stability sideways on very uneven ground, three speed changes, and an all-gear drive, whereas the inside wheel engine has only two speeds, and a pitch chain drive from the intermediate shaft to the main axle. The boiler and engine on both are identical; the former is of the locomotive type, and works at a pressure of 200 lb. per square inch. The standard size has a fire-box suitable for burning coal or coke, but a larger box can be provided for burning wood when required. The engine is compound, with side-by-side cylinders. The tank is of sufficient capacity for half a day's ploughing, under ordinary circumstances, without replenishing. These tractors are provided with governors, a large fly wheel, winding drum and steel wire rope, water lifter, injector, and the usual outfit of lamps, tarpaulin cover, &c.

Davey, Paxman and Co., Limited, of Colchester, exhibit a traction engine, a gas engine and a gas producer, and a horizontal steam engine. The gas engine, which is of new design, is shown in Fig. 3, and the producer in Fig. 4. The generator of the latter is built up of mild steel plates. The cast iron vaporiser which supplies the steam to the plant is placed so that it is heated by the gases leaving the producer. Heat is thus abstracted from the gases so that they are cooled before entering the scrubber, and less cooling water is required in the latter than would otherwise be needed. The design of the vaporiser is such that the whole of the inside can be inspected with ease. The air and steam supply to the producer is under absolute control, but at the same time there is an absence of plug cocks or valves, which are often a source of trouble. Hand holes and cleaning covers are provided on the gas pipes between the generator and coke scrubber, and poking holes are arranged on top of the producer. The body of the scrubber is built up of mild steel plates riveted together, but the base is of cast iron, which resists corrosion better than steel plate. The water sprinkler is of an improved design in which effective distribution is said to be obtained without the use of fine spray holes. An adjustable socket has been fitted in the gas pipe between the generator and the scrubber, with the aid of which it is possible to vary the relative positions of the generator and the coke scrubber. The engine is capable of developing 32 to 36 brake horse-power when running on suction gas. The base plate extends beneath the cylinder as far back as the combustion chamber, thus supporting the cylinder along the whole working length. The base plate is well ribbed and has an oil trough. In accordance with the usual practice the cylinder is fitted with a loose liner, and the breech end is removable and separate from both cylinder jacket and liner. The crank shaft bearings are fitted with self-oiling chain lubrication, as are also the side shaft bearings. Forced lubrication is adopted for the cylinder. The crank pin bearing is fitted with a dust-proof centrifugal ring oiler, whilst the piston pin is lubricated by means of an adjustable sight feed lubricator. All the gas and exhaust valves are placed vertically in the breech end, the admission valve being surrounded by a water jacket. The exhaust valve also works in a loose cast iron water-cooled guide. The valves are operated by a single cam. Magneto-electric

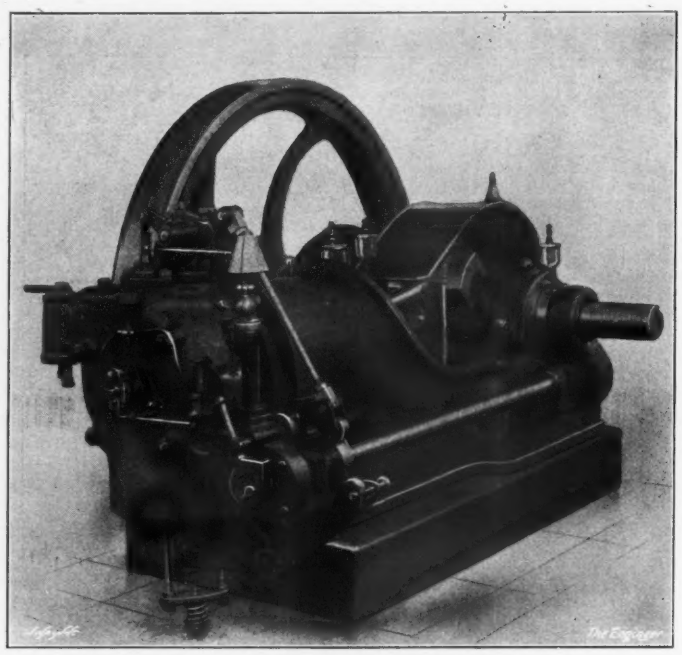


Fig. 3—PAXMAN'S PRODUCER GAS ENGINE

ignition is used. From the illustration it will be gathered that the engine has a single fly-wheel, a driving pulley, and an outside bearing. The starting of the engine is automatic, a cam on the side shaft being used to actuate the starting valve at the right moment. By the arrangement for the automatic admission of air all risks of failure and accident are said to be avoided, and the engine is started without the least difficulty.

The stand of Ruston, Proctor and Co., Limited, is an attractive one. The exhibits comprise a 4ft. 6in. thrashing machine, a 4ft. clover huller with one pair of shafts, a traction engine, and a Ruston patented oil engine. The thrashing

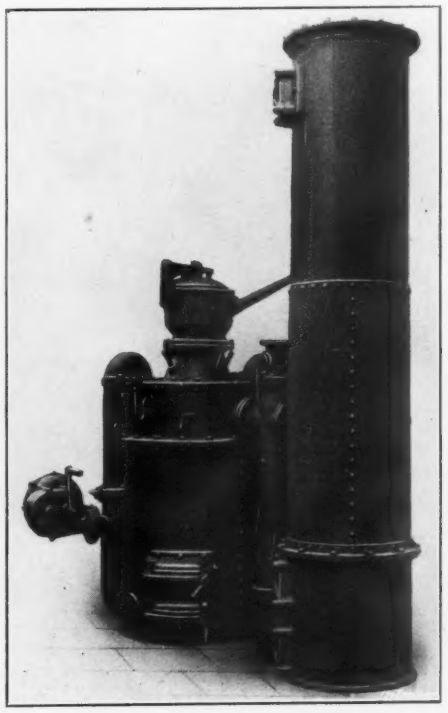


Fig. 4—PAXMAN'S SUCTION PRODUCER

machine deals with wheat, barley, oats, rape, linseed, mustard, carraway, rye, and peas. One operation suffices to obtain grain ready for the market, but the grain passes through nine different processes before it leaves the machine. The grain is sacked at one end of the machine away from the straw cavings and chaff, all of which are delivered separately at the other end. The machine is fitted with a rotary corn screen, which separates, classifies, and assorts the grain according to its size, in first, second, and third grades ready for the market. By turning a handle the wires can be set to the required distance apart for the work in hand. A revolving brush dislodges the corn wedged between the wires, thus retaining the efficiency of the whole of the screen area. The Ruston "Champion" clover huller has an iron thrashing drum, and is fitted with a concave which can easily be adjusted from the outside of the huller. The clover straw is fed into the top drum mouth in the ordinary manner, and the drum knocks off the heads of the clover straw, some of the heads going through the concave and the rest, together with the straw, on to the shakers, which separate the heads from the straw. Next the clover heads are lifted and delivered into a cylindrical cage by a centrifugal elevator arranged on the outside of the huller. A drum inside the cage throws the clover heads against the steel wire lining of the cage and rubs them on it by rotation, some of the seeds falling through the meshes of the wire and the remainder passing out of the opening of the cage, whence they fall on to the bottom shoe. The seeds mixed with the broken clover heads are now passed on to the first dressing riddle, where they are separated from the larger particles of broken clover heads. Further separation is effected by the second and third riddles. A fan is provided at the back end of the huller which directs an air blast over the above riddles, clearing away any dust and other refuse from the seed. The latter is now collected in a transverse spout and conveyed to an elevator which delivers it to a second dressing apparatus at the back end of the huller, in which it is arranged in a series of sieves. A second fan is placed so that an air blast can be directed over the surface of these sieves, carrying away any dust or broken matter which may still remain with the seed. After passing through this second dressing apparatus the seed is delivered ready for the market. The traction engine is a 7 horse-power single-cylinder engine of the firm's well-known type, and the oil engine exhibited is capable of developing 7 brake horse-power.

Oil and steam engines, corn grinding and crushing mills, cake breakers, &c., are shown on the stand of E. R. and F. Turner, Limited, of St. Peter's and Grey Friars Works, Ipswich. Two sizes of oil engines are exhibited, one of 5 horse-power and the other of 8 horse-power. In this firm's design of oil engine, the base contains the oil reservoir, which can easily be removed for cleaning. A "John Bull" horizontal steam engine is shown. It is designed for a pressure of 100 lb. per square inch, and develops 13 brake horse-power. As regards the mills there is one for crushing oats, grinding maize, beans, &c. There is also a range of "Inkoos" grinding mills. A small flour mill is also exhibited. This is for making Standard and similar brands of flour. It consists of one of Turner's "Sirdar" mills fitted with vertical stones.

An excellently finished agricultural locomotive and a steam tractor is shown on the stand of Charles Burrell and Sons, Limited, of St. Nicholas Works, Thetford. The locomotive is rated at 6 horse-power. The firm constructs these engines on the three or four-shaft principle, but the three-shaft engine is recommended for all purposes, as it is lighter, simpler, and more powerful. There is no necessity to enter into the details of the construction of Burrell's locomotive engines, as they are well known; but with regard to the tractor it may be stated that these are built on the same leading principles which have been so successful with the heavy road locomotives. The practice of driving each hind wheel separately off the countershaft is maintained, and its usefulness has been found to be even more marked in smaller engines than in the larger sizes.

As is customary, Aveling and Porter, Limited, of Rochester, exhibit several excellent engines. This year they show a road locomotive, a steam motor tractor, and a ploughing engine. Blackstone and Co., Limited, of Stamford, are showing portable and stationary oil engines, swath turners, a horse rake, and turnip cutters. The exhibits of Brown and May, Limited, of North Wilts Foundry, Devizes, Wilts, consist of a steam tractor and an oil engine. The Campbell Gas Engine Company, Limited, of Kingston, Halifax, Yorkshire, is showing oil engines, a gas engine, and a suction gas plant. A traction engine is shown on the stand of William Allchin, Limited, of Globe Works, Northampton. Another firm exhibiting gas and oil engines is Fielding and Platt, Limited, of 73A, Queen Victoria-street. A suction gas plant and a combined oil engine and pump is also shown on this stand. Stationary oil engines are also exhibited on the stand of Richard Hornsby and Sons, Limited, of Grantham. In addition, this firm exhibits a binder, a straw trusser, mowers, ploughs, and a drill. Cultivators, a swath turner, rakes, horse hoes, harrows, whippletrees potato diggers, mowers, &c., are shown by Martin's Cultivator Company, Limited. J. and H. McLaren, of the Midland Engine Works, Leeds, are exhibiting a traction engine, a plough, and pumps. Traction engines are also to be found on the stand of Wallis and Steevens, Limited, Basingstoke.

The Daimler Company, which, we believe, has not been represented at the Smithfield Show before, is

exhibiting a 36 horse-power general purpose machine. The British Wagon and Carriage Company is showing its usual assortment of vans and carts, and also a range of its "Victoria" petrol engines. These are now fitted with Bosch magneto ignition. The firm of W. and T. Avery, Limited, exhibits weighbridges, weighing machines, scales, &c. A new exhibit on this firm's stand is a "foul air interceptor," which has been introduced to prevent impure air passing out of a weighbridge pit into the weigh-office by way of the pillar which supports the steelyard. Briefly, it consists of a circular casting containing water, in which a brass dome is partly immersed. The rod which passes through the pillar and the connecting link to the weighbridge lever are joined to this dome, which can freely rise and fall, whilst the liquid into which it moves forms a trap and stops the foul air from passing. Another firm showing weighing machines is J. T. Poupard, of Tooley-street, S.E.

A new potato digger is shown on the stand of Blackstone and Co., of Stamford; there are also portable and stationary oil engines, swath turners, a horse rake, turnip cutters, &c. The oil engines are of several types. There is one of the firm's portable oil engines mounted on an open steel girder frame which is carried on cast iron wheels. The system of cooling is by a circulating water vessel. All these engines have steel girder frames, balanced cranks, and two fly-wheels. An example of the firm's crude oil engine is also shown. These engines are designed to work with Scotch shale and other crude oils, such as Texas, Borneo, and Russian. Petroleum residue may also be used. The compression of the charge is comparatively low, viz., 150 lb. per square inch. A dual spraying device is used, consisting of a main jet adapted to deliver its charge into the combustion chamber, and an auxiliary one delivering a smaller charge into a bulb-shaped ignition chamber heated at starting by a lamp and afterwards kept hot by the combustion of the fuel. The ignition chamber communicates with the combustion chamber by a port so arranged that the flame produced in the ignition chamber impinges upon and ignites the main fuel spray in the combustion chamber. The oil is delivered from the tank to the spraying device by a governor-controlled pump, and first reaches the auxiliary or igniter spray. All oil in excess of the quantity required overflows into the main spray. This method ensures a charge of oil being injected into the igniter at every cycle, thus keeping it hot, irrespective of the engine running light or loaded. The air compressor for the sprays is attached to the side of the cylinder, and is worked by an excentric on the crank shaft. An object kept in view in the design of this engine has been to prolong the initial pressure of the explosion in the cylinders.

The stand of Richard Garrett and Sons, of Leiston, is to be found in the usual position, and in accordance with the firm's general practice a fine example of a semi-portable superheated steam engine is shown. This type of engine, however, is well known to our readers, and calls for no comment. Perhaps the most attractive exhibit is a three-ton superheated steam wagon, which is mounted on rubber tires. It has cylinders of 3¼in. and 5¾in. diameter, and a 6in. stroke. The cylinders are mounted on the boiler, and valves are fitted to enable both to be supplied with high-pressure steam. The superheater consists of tubes fixed in a header, which is suspended in the smoke-box over the top row of boiler tubes. We understand that one of these tractors recently carried a load of three tons for 48¼ miles with a coal consumption of 178 lb.

As in former years the firm of J. and F. Howard, of Bedford, exhibits a good collection of its manufactures, including the firm's well-known "Champion" ploughs. Various sizes of ploughs are shown, ranging from the four-horse size to the general purpose and pony plough for allotment holders. Steam and motor ploughs are made by this firm in all sizes, one of the most representative examples being the four-furrow plough now largely used for direct haulage by steam and oil tractors. Swath turners and rakes of different strengths are exhibited, and the latest baling press, the "Lion," which we are told is now much in demand, is an exhibit which attracts much attention.

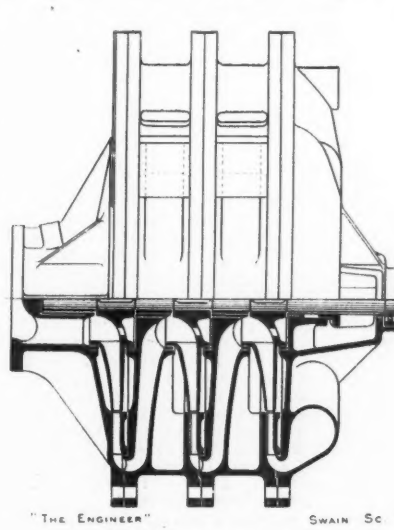
MOTOR-DRIVEN CENTRIFUGAL PUMP FIRE-ENGINE.

A MOTOR fire-engine, fitted with a centrifugal pump, has recently been completed by Merryweather and Sons, of Greenwich, for the Renfrewshire County Council. It is an entirely new design, called by its makers the "Non-primed" pattern. It is fitted with a 70-75 brake horse-power six-cylinder petrol engine of the Merryweather-Aster type, which is specially designed for fire brigade requirements. Duplicate systems of ignition are provided—high-tension magneto and battery and coil. The carburetter is of the automatic quick-starting two-jet type. Lubrication arrangements of the combined forced and splash systems are provided. It sometimes happens that a fire-engine, when performing pumping operations at a fire, has to stand on inclined ground. In order that the efficiency of the lubrication should not be impaired under such conditions, the oil sump is cast nearly in the centre of the crank chamber base, and has inclined channels leading into either side.

The engine is water-cooled, a large water tank being provided, and the circulation is effected by means of a centrifugal pump driven by a spur gear wh el meshing with the inlet timing gear wheel. From this pump branches are taken leading to either side of the engine, and inlets to the jackets are fitted on both sides of the cylinders. The effect of this arrangement is that the two streams of water flowing in opposite directions meet each other and are forced down to the bottom of the jackets, which, it is claimed, ensures more efficient cooling than is the case when the water merely circulates through the jacket without opposition. The radiator is of the tube-and-fin type. It has a cooling surface, and is of very substantial construction.

The transmission is by a multiple disc clutch and a universal jointed shaft through change-speed gear to differential shaft, the rear wheels being driven by steel roller chains. Messrs. Merryweather consider that a chain drive is undoubtedly best for heavy vehicles of this type, where great strength is a most essential factor. The gear-box is fitted throughout with ball bearings. Three forward speeds and a reverse are provided, and we are informed that the engine at the official trials did the measured mile, fully loaded, in 1 min. 40 sec., which is at the rate of 36 miles per hour. The steering gear is irreversible. There is a vulcanite-covered hand wheel on an inclined pillar, and the levers for the throttle and the ignition systems are on the face of steering wheel. The brakes are in duplicate, viz., foot pedal acting on a drum on the second-motion shaft, and a hand lever, operating internally, expanding brakes on the hind wheels. They are made extra powerful for emergency stops.

The fire pump is of the centrifugal type, and is constructed with three stages. It is driven from the motor from an extension of the first motion shaft in the change-speed gear-box, and can be instantly thrown in and out of gear by means of hand lever. Charging is effected by means of a high-speed vacuum pump of Merryweathers' patented type. The vacuum pump is driven by a friction clutch and gearing from the motor, and is operated by foot pedal from the driver's seat. A suction lift of 28ft. can be quickly obtained by this means, and it is not necessary to employ a retaining valve on the suction pump to ensure continuous supply. The fire pump has a capacity of 450 gallons per minute, and is fitted with one 3½in. and two 2½in. delivery outlets.



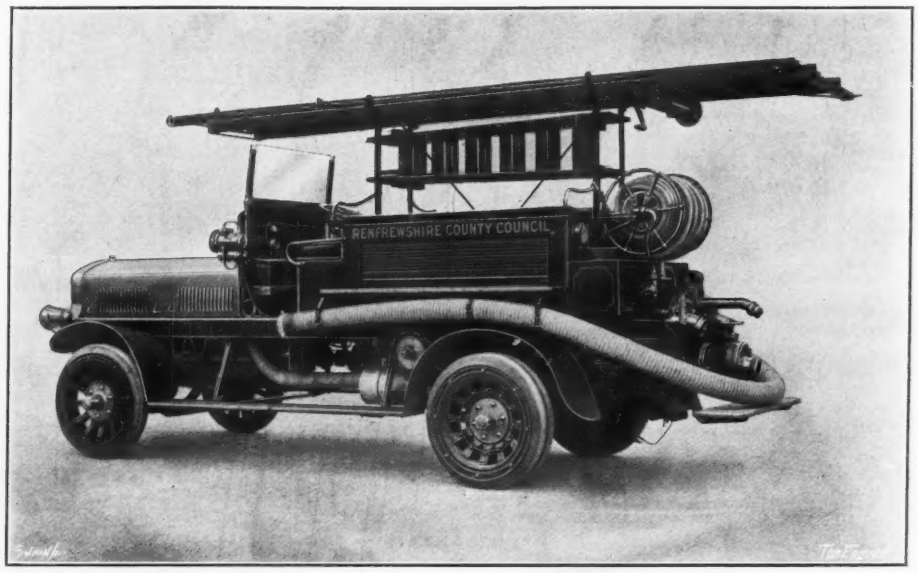
SECTION OF THE FIRE PUMP

At the rear of the machine a 30-gallon water tank is carried, and over it is fitted a hydraulic reel containing 180ft. of rubber hose with nozzle. By utilising the water in this tank the main pump can be employed for "first-aid" purposes. A large hose box is arranged over the centre of the vehicle, the top of which is fitted with garden pattern seats for the firemen. Ready access to the box is provided by means of automatic roller shutters. The footboards are covered with chequered aluminium, and edged with brass. The chassis is fitted with special flat springs of unusual length, so as to give extra resiliency combined with strength. A wrought iron framework is fitted on top of the hose box to carry a 40ft. extension ladder and four fire brigade scaling ladders. Two additional scaling ladders and a 13ft. 6in. folding "Pompier" ladder are also included in the equipment.

The lighting arrangements comprise a dynamo set connected to two electric headlamps and one tail lamp. There are also two self-contained acetylene headlamps and two head and hand oil lamps. Three alarms are fitted, viz., an electrically driven syren, an electrically driven fan organ whistle, and an ordinary bulb and horn. A wind screen is also provided. Sixteen men can be carried, sitting and standing.

MOTOR FIRE ENGINE WITH CENTRIFUGAL PUMP

MERRYWEATHER AND SONS, LIMITED, GREENWICH, ENGINEERS



The engine is destined to serve a large area in the county of Renfrew, comprising the parishes of Cathcart, Eastwood, Neilston, Mearns, Eaglesham, a portion of Paisley parish, and the burgh of Pollokshaws. To cover all this ground a motor fire engine was deemed essential, as horses could not reach the confines of the area within reasonable time. The engine is stationed at Pollokshaws, and a brigade has been formed consisting of three permanent firemen and twelve auxiliary firemen, the latter being members of the county police force. It is calculated that this brigade, with the engine and appliances at their command, will be able to cope with all fires that may occur within the prescribed area.

As a matter of fact, shortly after the engine was delivered a call came from a fire 12¾ miles from Pollokshaws. The distance was covered in 31 minutes from the receipt of the call. The engine was working for 5½ hours, and for the first hour six lines of hose were employed.

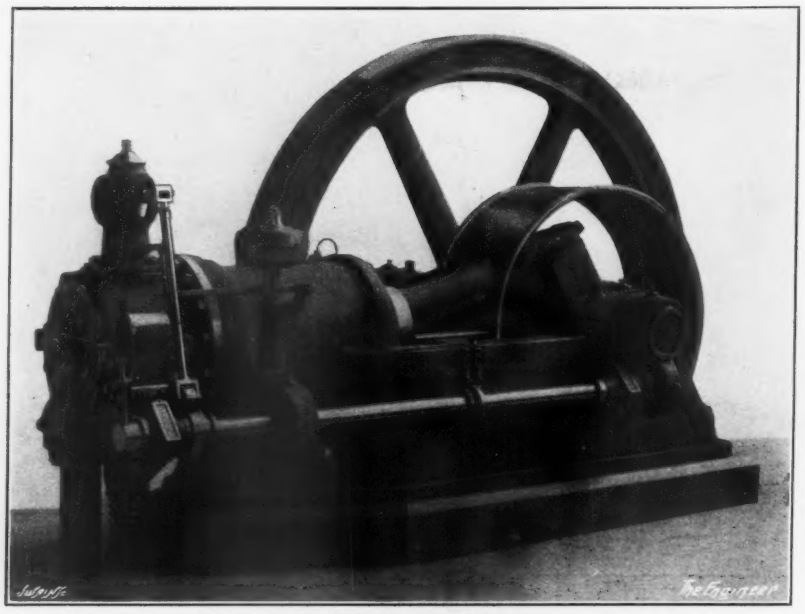
COAL-CUTTING MACHINERY.

A PAPER on the above subject was read before the Manchester Association of Engineers on Friday, November 24th, by Mr. W. Bolton Shaw, M.I. Mech. E. The author commenced by describing the chief systems of working coal mines, namely, the "Longwall" and the "Pillar and Stall" systems. Then, after describing the method of working by hand, he went very fully into mechanical cutting, and divided the machines employed into two classes, namely, "percussive" machines, which imitate fairly closely the action of the collier's pick, and "rotary" appliances, in which the action is similar to that of an ordinary machine saw or milling cutter. For percussive machines compressed air is almost exclusively employed, no really successful electrical machine of this type having, according to the author, been yet evolved. A type which embodies a sort of compromise between electricity and air has lately appeared in America and is said to have met with a considerable measure of success. In machines of this class the actual reciprocating motion is produced mechanically by an electric motor and is transmitted by compressed air to the percussive tool, the whole apparatus being practically self-contained. The paper then went on to deal with the two types of percussive machines. These are the "pick" machine, or "puncher," and the heading machine, or "header." An interesting machine of the "puncher" class is the "pneumelectric," which is of American origin, and has not yet been taken up extensively in this country. Of rotary machines there are three types, namely, the disc, the chain, and the bar. In the disc type the cutting member consists of a large disc carrying cutting tools on its periphery, and its action is similar to that of a circular saw. In the chain machine the cutting member consists of a chain, of which alternate links carry cutting tools, and its action may be compared to that of a band-saw, with the saw working in a horizontal plane and having its teeth on the inside of the band instead of on the edge. The bar type cuts by means of a long bar carrying cutting tools projecting radially. The bar rotates at a high speed and in the cutting action resembles a side milling tool of great length and small diameter.

The advantages and disadvantages of the various types of machines were then alluded to by the author. With regard to electrically operated machines, Mr. Shaw said that with direct current the series motor is generally adopted for disc and chain machines and the compound motor for the bar machines. The advantages of the series motor are its excellent starting torque, which is particularly valuable with the disc, and the characteristic it possesses of slowing down under an overload, thus tending to ease the machine. In three-phase machines the slip-ring motors are used for the disc, and both slip-ring and squirrel-cage for the chain; for the bar machine the squirrel-cage only is used. Probably the chief recommendation of compressed air machines is the absence of any danger of firing gas, or risk of shock to the men. It was pointed out that they had defects which in many cases outweighed the advantages. The efficiency as regards power consumption is much lower than that of electricity, the steam consumption for a compressed air plant being about double that of an electric plant.

30 B.H.P. GAS ENGINE

AMBROSE SHARDLOW AND CO., LIMITED, SHEFFIELD, ENGINEERS



A NEW GAS ENGINE.

THE accompanying illustration represents a 30 brake horse-power four-cycle gas engine which we recently had an opportunity of inspecting while running at the works of the makers, Ambrose Shardlow and Co., Limited, Ealing Works, Sheffield. The engines are made in various sizes from 10 to 100 horse-power, and are very substantially built, while special alloy steels are used for all parts which are subject to hard wear and shocks. The governing is on the throttle system, the mixture remaining constant in quality. With the system of valve gear employed a wide range of speeds is obtainable. For instance, with the engine illustrated the normal speed is 260 revolutions per minute, but the speed can be reduced to about 35 revolutions per minute on a light load. Amongst the special features of the engine it will be observed that the valve gear is of neat and simple construction with a minimum number of parts. All the actuating mechanism for the inlet and exhaust valves is in one central plane to avoid twisting stresses being set up in the various pins. The practice of using pins that are overhung is avoided, the pins being supported in forks or jaws. Both the inlet and exhaust valve mechanism are designed to ensure durability, no cast iron being used in these parts or in any other fitting that is subjected to heavy stresses when in use. For instance, the exhaust valve lever is made of chrome vanadium steel. Another feature in connection with the valve mechanism is the employment of one cam for actuating the two valves, and this cam is made of a special steel alloy. The roller that works in contact with it is made of 3 per cent nickel steel, and the same material is used for both the inlet and exhaust valves.

The timing mechanism for the high-tension magneto-ignition has an automatic locking device of neat design. A special form of index enables the attendant readily to fix the time of the spark which gives the best running results. The sparking plug is placed in an accessible position for removing and cleaning. It is made so that trouble due to the fixing of the striking spindle by rust or deposit is impossible. The lubrication of the several parts forms the subject of a patent. As will be observed from the illustration, a part of the engine bed is made to form an oil reservoir, and this is fitted with a division plate to enable two qualities of oil to be used, one for the cylinder and another for the crank pin. The only limit to the capacity of the oil chambers is the size of the engine bed. No glass lubricator is employed, the oil being supplied to the various parts by means of positive pumps of the plunger pattern fitted with ball valves and delivering through small sight tubes. The quantity of oil delivered by the pumps is controlled by the stroke of the pumps, which is capable of regulation.

The main bearings, outer bearings, and the lay shaft bearings, are all fitted with ring lubricators, and the skew gears for the lay shaft and governor are arranged to run in an oil bath. Another feature worthy of special mention is the splash-guard for the crank pin and connecting-rod. The means employed for fixing this guard are simple and effective, the beading itself being opened out to form a flange or lug by which the guard is secured to the bed-plate. The breech end of the engine has a loose cover, which can be easily removed so that the attendant can get his arm into the water jacket for cleaning out deposit—a desirable arrangement in case the local water contains lime. The terminals for the sparking plug and magneto apparatus are of a new form invented by Messrs. Shardlow, and involve no soldering. The socket for the terminal is made to support both the insulation and the wire, and it is found that there is no tendency for the insulation to fray out and leave the wire exposed as frequently happens with some forms of terminal.

Messrs. Shardlow are also introducing a new suction gas producer, which is constructed so that it is possible to place the scrubber in at least six positions in relation to the generator without making any alteration to the various parts.

BRIQUETTES made from Nigerian lignite under the supervision of the Imperial Institute are stated to have a calorific value but little inferior to that of some varieties of coal; they are impermeable to water, and can be stored for long periods without disintegration.

PANAMA SCRAP.

OF the £52,000,000 dissipated by the Universal Oceanic Canal Company during its brief and meteoric existence, about £6,000,000 were expended in the purchase, transportation, and putting into place of probably the largest and most costly—certainly the most diversified—accumulation of machinery and plant ever assembled for the execution of a single work. Blessed, or otherwise, with boundless enthusiasm, the most sanguine of temperaments, and profound faith in his individual judgment and power, Ferdinand de Lesseps, in the heyday of his prosperity, was a veritable treasure-trove to the mechanical engineer. His predominant desire, during the years immediately following the successful flotation of his Panama Canal Company, was to inoculate all men of all nations with his indubitably honest, if indiscriminate, convictions; and to the pursuit of this idea must be attributed, in large degree, the fatal extravagances and open-handed hospitality to every conceivable form of "proposition" which characterised this period of his career. The result was palpable when, after the colossal *débâcle* of 1888 and the subsequent transfer of the property to the United States, systematic attempts were made to classify and enumerate the thousands of items of machinery and plant—more or less derelict or unserviceable—gathered in the storehouses of the Isthmus or entombed in its rivers and jungles. Of the gravity of the scandal many stories have been told—fantastic, exaggerated, and even wholly imaginative—and of these, thanks to frequent iteration, not a few have been accepted as sober truth. As a matter of fact, the moral has been too obvious to require other than well-authenticated illustration. We are content to regard as a sailor's yarn the alleged consignment to this tropical region of thousands of snow-ploughs, and to rely, for a general appreciation of the circumstances under review, upon unquestioned incidents. Of such, but three examples need be mentioned—the provision of some thousands of torches to be used in a series of fêtes, planned simultaneously with the commencement of operations, which were to celebrate the completion of the enterprise; the acquisition of numerous iron steamboats, carted to and set up at inland points along the Canal line, there to await the time when they might be floated in a channel existing merely on paper; and, finally, the purchase of huge and costly machines, the purpose of which remains to this day an inscrutable mystery to the survivors of the engineers who were expected to assemble the parts and put into commission the unfamiliar leviathans. There is, happily, one circumstance of which, at least, Great Britain may be proud, relieving the dominant gloom of this record of credulity and corruption. So conspicuous were British manufacturers in respect of fair dealing with de Lesseps that not a few products of their works, after withstanding years of neglect and the roughest of treatment, may be seen in the Isthmus to-day trying conclusions excellently well with the newest fruits of America's ingenuity and resources.

Throughout its negotiations with the second French company, the Isthmian Canal Commission of 1899-1901 resolutely set its face against the United States buying the plant as a whole, or making any special allowance for it in estimating the aggregate value of the property. As a result, not a dollar of American money was paid for equipments, which had cost £6,000,000, and was valued in the books of the company at £3,900,000. Yet already, it has been officially admitted by the United States authorities, one million dollars' worth of the material has been utilised in the work of completing the Canal, and a not altogether negligible sum has accrued to the administration by reason of sales to private individuals. There have also been sold in the United States as "scrap" 17,537 long tons, realising an average gross price of 11.86 dols. per ton.

Perhaps the most interesting and appropriate use which has been made of the surplus metal is in connection with the medals struck and distributed among all Canal and Panama Railroad employés of United States citizenship who have rendered two years' satisfactory service in the Isthmus—bars also being given for each additional two years' continuous service. These medals are of bronze collected from the French "scrap," and their distribution may be regarded as fulfilment of a promise made by Mr. Roosevelt, then President, at the close of his visit to the Isthmus in November, 1906. "I shall see," said he to an enthusiastic gathering of Canal builders at Cristobal, "if it is not possible to provide for some little memorial, some mark, some badge, which will always distinguish the man who for a certain space of time has done his work well on this Isthmus, just as the button of the Grand Army distinguishes the man who did his work well in the Civil War." A few examples of French machinery employed in the early years of Canal construction have been set aside for exhibition at the San Francisco International Exhibition and other public celebrations of the opening of the highway which are to be held during 1915. And now comes information that authority has been given for the disposal to a Chicago house-wrecking company of all the remaining French equipment and scrap metal in the Canal Zone, not already in use or taken into stock. It appears that offers for the property were advertised for in the United States, and that in all eleven tenders were received, the prices quoted ranging from 40,000 dols. to 215,000 dols. Of the other bids, five were for amounts less than 100,000 dols., three for amounts between 100,000 dols. and 200,000 dols., and one for more than the last-mentioned sum. Included in the material thus disposed of are many locomotives, dredgers, excavators, dump cars, boilers, cranes, and cylinders, and considerable quantities of steel rail and scrap iron, copper, and bronze. Provision has been made that all the material must be removed by the contractor from the places where it has been stored or was abandoned by the French, and transported to the seaboard at his own expense—a special freight rate of 2.25 dols. per short ton to either Colon or Balboa being granted by the Panama Railroad. With the completion of this contract, one unprecedented of its kind, will fall the curtain upon a protracted tragi-comedy, not altogether, as even their best friends must admit, to the credit of two great nations.

Less than two years hence there will, of course, be another monster sale of "scrap," namely, of that very considerable part of the construction plant and equipment purchased by the Americans since 1904, which will be of no use for Canal operation and maintenance. That the Canal Commission sets small store upon the amount of money likely to be realised by such sale is evident from the fact that it ventures upon no estimate of the possible value of the asset, but continues to write off and absorb into construction costs all expenditures upon plant and equipment, on the generous basis of the latter's total cost and the estimated quantities of work still to be done. Of the wisdom and propriety of such a course there cannot be a moment's question.

BOOKS RECEIVED.

City of Bradford Technical College Calendar, 1911 *and* 1912. Bradford: Thornton and Pearson, 58, Barkerend-road.

Steam Turbine Design. By John Morrow. London: Edward Arnold, 41 and 43, Maddox-street, W. Price 16s. net.

Elementary Workshop Arithmetic. By Henry A. Darling. London: Blackie and Son, Limited, 50, Old Bailey, E.C. Price 1s. 6d.

Peru of the Twentieth Century. By Percy F. Martin, F.R.G.S. London: Edward Arnold, 41 and 43, Maddox-street, W. Price 15s. net.

The Railway Conquest of the World. By Frederick A. Talbot. London: William Heinemann, 21, Bedford-street, Strand, W.C. Price 6s. net.

The Navy League Annual, 1911. Founded and edited by Alan H. Burgoyne. London: John Murray, Albemarle-street, W. Price 2s. 6d. net.

Electric Mains and Distributing Systems. By J. R. Dick and F. Ferne. London: The *Electrician* Company, Limited, Salisbury-court, Fleet-street. Price 10s. 6d. net.

Framed Structures and Girders: Theory and Practice. Vol. I. By Edgar Marburg. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 17s. net.

Elementary Manual on Heat Engines, Steam, Gas, and Oil. By Andrew Jamieson. Thirteenth edition. London: Charles Griffin and Co., Limited, Exeter-street, Strand. Price 3s. 6d.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon (the 4th inst.), Sir James Crichton-Browne, treasurer and vice-president, in the chair. Miss Goldsmid, Dr. Habibur Rahman Khan, Dr. W. M. Nootl, and Mrs. Middleton Robinson were elected members, and Professor W. C. Brögger (Christiania), Geh. Rath Professor T. Curtius (Berlin), Professor P. A. Guye (Geneva), and Geh. Regierungs Rath Professor H. Rubens (Berlin) were elected honorary members. The special thanks of the members were returned to Mr. D. J. Blaikley for presenting to the Institution, from the bequest of the late Miss J. Barnard and at her express wish, a large volume of Faraday's containing engravings, portraits, and letters. The chairman announced that the managers at their meeting held that day had appointed Mr. W. Bateson, M.D., F.R.S., Fullerian Professor of Physiology for a term of three years. The following are the lecture arrangements of the Institution before Easter:—Dr. P. Chalmers Mitchell, a Christmas course of six illustrated lectures on "The Childhood of Animals," adapted to a juvenile auditory: (1) Introductory, (2) The Duration of Youth, (3) Colours and Patterns of Young Animals, (4) Young Animals at Home, (5) The Feeding of Young Animals, (6) The Play of Young Animals; Mr. W. Bateson, Fullerian Professor of Physiology, R.I., six lectures on "The Study of Genetics"; Professor E. G. Coker, two lectures on "Optical Determination of Stress, and some Application to Engineering Problems"; Dr. T. Rice Holmes, three lectures on "Ancient Britain"; Professor A. W. Bickerton, two lectures on "The New Astronomy"; Professor A. M. Worthington, two experimentally illustrated lectures on "The Phenomena of Splashes"; Mr. M. H. Spielmann, two lectures on "The Portraiture of Shakespeare"; Mr. F. A. Dixey, two lectures on "Dimorphism in Butterflies": (1) Seasonal Dimorphism, (2) Sexual Dimorphism; the Rev. John Roscoe, two lectures on "The Banyoro: A Pastoral People of Uganda": (1) The Milk Customs, (2) Birth and Death Customs; Sir Alexander C. Mackenzie, three lectures on (1) "Russian Music of To-day" (with the kind assistance of the Hans Wessely Quartet), (2) and (3) "Franz Liszt (Centenary)," with musical illustrations; Professor Sir J. J. Thomson, Professor of Natural Philosophy, R.I., six lectures on "Molecular Physics." The Friday evening meetings will commence on January 19th, when Professor Sir James Dewar will deliver a discourse on "Heat Problems." Succeeding discourses will probably be given by Professor Bertram Hopkinson, Dr. J. Mackenzie Davidson, Dr. J. A. Harker, Rt. Hon. Sir John H. A. MacDonald, Mr. G. K. B. Elphinstone, Dr. W. J. S. Lockyer, Mr. F. Soddy, Professor D'Arcy W. Thompson, Professor Sir J. J. Thomson, and other gentlemen.

REPORT ON LONDON TRAFFIC.

THE fourth annual report of the London Traffic Branch of the Board of Trade was issued at the end of last week. This production is always interesting. The traffic problem which London is now facing and attempting to grapple with is to a certain extent peculiar to itself; but there are few large cities which to-day are not beginning to feel the pinch of the broader issues of the same problem. For this reason the report is of much wider interest than its title might imply.

The present report deals principally with the aspect of the question in the year 1910, and to a limited extent with the changes which have occurred in the situation during the current year. Its main object is to bring up to date the information given by the Royal Commission on London Traffic, which concluded its work in 1905. London, more so probably than any other city in the world, has grown without plan or method. Without incurring an enormous expense it would now be impossible to alter or improve the existing traffic facilities in the central districts. Congestion here seems inevitable unless means, such as underground travel, can be devised which will remove a part of the traffic from the roads. That such a proposal is engaging the attention of at least one department responsible for an appreciable amount of road traffic in the heart of London is now generally known. The Post-office Departmental Committee appointed to consider the question reported in February of this year that for postal purposes an underground electric railway 6½ miles in length should be constructed from the Eastern District Office in Whitechapel-road, through the heart of the City to Paddington Station. It is estimated that the equivalent annual expenditure on such a scheme would actually be less than that now required for the maintenance of the road mail van services. In addition, it would suppress 5000 to 6000 daily journeys on the road. The scheme is obviously applicable to many other enterprises, and in particular to the parcels delivery systems of the railway companies.

While it is by means such as these that the problem will in all likelihood be solved in the central districts of London, the situation in the outskirts, although beginning to assume the same aspect, can be remedied by other means, and may be entirely obviated by the adoption of a well considered scheme. The details of such a scheme are now practically completed, and are embodied in the report now before us. Lack of space prevents us dealing now with the subject at the length its importance demands, but in next week's issue we hope to return to the matter.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ELECTRICAL SHIP PROPULSION.

SIR,—The above question is very interestingly dealt with in your issues of the 17th and the 24th of November last. I should like to be in a position to be able to add a few remarks in support of the electrical method of providing the necessary thrust for main propulsion, a question, as you are aware, to which I have given considerable attention, and which I have advocated for some years. Most articles on the subject deal with the scheme as one that provides a ready means of economically applying the steam turbine or the internal combustion engine at sea, and take advantage of the facts that these two prime movers are inherently high-speed pieces of mechanism, and have shown a very poor result generally when applied to direct main marine propulsion by reason that owing to atmospheric and other conditions the screw propeller is a slow-speed piece of mechanism, and an inefficient compromise between the two units has been adopted in many cases. The whole question of electrical propulsion is one, however, of economy in operation, and forms a means by which the necessary thrust for propulsion can be obtained, with the minimum of heat units used per 1000 ton-miles of displacement at any given vessel speed and operating conditions. There are many things to be taken into consideration when getting out a scheme for main propulsion, however, and to which apparently little consideration has been given.

The starting point is, what are the requirements of the owners? as all owners or operating companies have their own particular methods, practices, and customs, and these must be adhered to in each case, and the plant generally designed to meet same. For given carrying capacity at given speed, there are, however, certain fundamental requirements which govern the size and character of the vessel. First, is the number of tons of cargo to be carried, and its general character, then the speed necessary to maintain a given schedule between ports and the trade routes, and also the amount of fuel to be carried to meet the conditions; then comes the important question of type of machinery, and weight and space taken up by same, and bearing in mind the placing of the plant in such a position which is best, when taking the fact that the vessel will not always be working in a loaded condition, again certain climatic conditions have to be studied according to the class and route for which the vessel is built, come into the consideration. Then comes the design of hull most suitable as found by past experience of the naval architect. The form, length, beam and draught having now been considered necessary to safely carry the cargo and machinery, &c., at given speed.

Taking the whole question into consideration, and bearing in mind that owing to depth of water varying the world over at various ports, and also when looked at from the point of cost of operation, capitalisation, and amount of power required to maintain certain speed at sea, and to maintaining of that speed with the least amount of heat units used, electrical propulsion shows up first in the list of the various methods that have been put forward as a means of propulsion of any class of vessel.

There is no question of the fact that by means of a slow-running, large area propeller of any description, owing to limitation of the pressure of the atmosphere, that there is a critical speed, that water may be moved by propellers for producing the maximum thrust per shaft horse-power for propulsion, and claims for efficiency from new types of propellers that have been fitted on boats using high-speed prime movers can generally be traced back to improvements in naval architecture, making it possible to push a certain vessel along with less thrust, or to give a higher speed for the same thrust and power, the credit of this undoubted improvement in naval architecture has been given to supposed improvements in screw propellers, with an attempt to show that same are efficient at high revolution speed in order, perhaps, to make these latter-day high-speed prime movers, such as the steam turbine and the internal combustion engine, appear to be efficient for that purpose.

The fact that with these latter-day prime movers a much higher temperature is essential, in order that they shall be efficient in fuel, makes it absolutely essential that same shall have a high rate of revolution speed, as is shown in practice with the superheated steam turbine and internal combustion engine as applied in power stations on shore; this is required in order that the high temperature shall have the least time exposed to the, comparatively speaking, cold walls of cylinders and cases, &c. As all these advantages can be secured in the case of the generating plant required in the case of electrical driving, the facts are these, that in no other case can such economy, control, reversing, and safe speed regulation at sea, be maintained as can be obtained on a ship fitted with electrical plant for main propulsion purposes, and this is especially true in the case of the plant being designed for polyphase alternating current with single air-gap motors of the squirrel-cage induction type, as in that case, by means of variable frequency and voltage, current being provided, then the usual losses are avoided, when the motors are running at low speed and load when in fog and under other sea-going conditions; the economy that can be obtained when working in such, by means of electrical driving, makes it all the more surprising that other schemes are still brought out and proposed, in the form of non-variable mechanical gears, a method that I gave up as impracticable many years ago whilst engaged in the investigation of this one of the promising methods of the future transportation of passengers and freight at sea. In the case of the electrical-driven ship, and speaking from experience that has been derived from actual investigation of ships at work, and the cost of operating same, and the amount of heat required for certain duty, it has been found that in all cases the electrically driven boat shows up to the commercial advantage of the owners to a high degree.

London, E.C., December 2nd. WILLIAM P. DURTNALL.

THE MECHANICAL PRODUCTION OF RUST.

SIR,—Reference was made in this journal—November 24th, 1911, page 542—a short time ago to an interesting paper read before the Institution of Mechanical Engineers in October last on "The Endurance of Metals." The authors, Messrs. Eden, Rose and Cunningham, draw attention to the fact that the pieces of steel subjected to stress in the course of their experiments were invariably rusted at those portions gripped by the holders, so much so that "in the case of heavily loaded tests lasting for several days . . . it was often difficult to remove the broken specimen from the holder." In one of the machines the production of a considerable quantity of rust had been observed. It is therefore concluded that this corrosion is due to the varying stress between the test specimen and its holder. It is a well recognised fact that iron will not rust in the absence of at least traces of liquid water, and the question which naturally arises is, Where did the necessary water come from in the above experiments? Through the kindness of the secretary, Mr. Edgar Worthington, of the Institution of Mechanical Engineers, I have been able to read a copy of the paper by Messrs. Eden, Rose and Cunningham, and a careful study of the same leads me to the conclusion that the moisture can scarcely have been obtained from the air or surrounding objects. This would appear to be confirmed by the fact that previous oiling of the specimens did not prevent the corrosion entirely.

The true explanation is that the necessary water was already present within the pores of the iron itself. This seems rather an astounding statement to make, but it is none the less true.

For a very long time chemists have recognised the fact that cast iron is porous, and nearly a hundred years ago Juncker suggested that cast iron pipes might with advantage be rendered impervious to moisture by forcing linseed oil under pressure through their walls, so that on "setting" the oil would fill the pores of the metal. More recently Jouve has illustrated in a most convincing manner that alloys of iron and silicon are porous, for masses of the metal weighing several kilogrammes after soaking in certain solutions showed a decided increase in weight, although not the slightest trace of corrosion was observable. When we come on to consider steel, however, we have a body of very compact form, and correspondingly delicate tests must be tried if we are to detect porosity in it.

Heathcote gave in 1907 an account of an interesting experiment tried with a piece of dried steel which had been previously dipped in nitric acid. The metal was placed in a glass vessel and evacuated until the pressure fell to less than one thirty-thousandth of an atmosphere. It was observed that the steel gave off gases very slowly, so that, after the lapse of rather more than one hour, the pressure inside the tube had risen to approximately one three-thousandth of an atmosphere. Where had the gas come from? Out of the pores of the metal.

The porosity of iron and steel may be still further illustrated in the following way:—Samples of the highly polished metal are soaked in strong solutions of caustic potash for several weeks. On removal they are washed and carefully dried, and even rubbed with emery paper if desired. On placing these in a small quantity of water for a few days, of course they rust, but if the water is tested by the usual flame test for potassium, the presence of potash can readily be detected. It had diffused into the pores of the metal during the three or four weeks of immersion in the potash, and now diffused out again into the pure water.

Other equally convincing experiments may be tried proving that even compact iron and steel are minutely porous. Referring now to the experiments of Eden and his collaborators. The previous history of the steels is not given, but one or two are distinctly stated to have been in stock for some time. Presumably they, in common with all other steels, were slightly hygroscopic, and had absorbed a little moisture in their pores. The great pressure to which the test pieces were subjected squeezed the traces of water out of the pressed portions, and rusting ensued in consequence of the galvanic action such moisture would immediately cause between the test piece and the holder. A simple explanation for the phenomenon is thus to hand, and thoroughly in accordance with our knowledge of iron and steel.

Darlington. J. NEWTON FRIEND.

[Mr. Newton Friend's explanation is highly ingenious, but we doubt if many will accept it as "simple." It is far simpler to believe that moisture had settled from the manipulator's hands or breath on the specimen at the time it was being put into the holders. The oil is the difficulty in both cases, and it seems to us practically insurmountable in the case of such infinitesimally minute traces of water as would be squeezed out of a polished steel bar ½in. diameter in 2½ hours (Saniter). Moreover, a bar which had been reduced from a large body of metal, would be very unlikely to contain much water, as presumably absorption is very slow. On the other hand, if palpable drops of water were on the metal they might be driven through the oil by the compression of the jaws of the chuck. If Mr. Newton Friend's explanation is true, how is it that the phenomenon does not appear regularly? Why does not steel rust under the jaws in a lathe chuck?—ED. THE E.]

SIR,—I have read with very great interest the leading article in your issue of November 24th on the "Mechanical Production of Rust." This question has been very much in evidence as the result of the mounting of ball bearings on shafts, and has become such a difficulty that we made several experiments here some two or three years ago with a view of overcoming it, but were quite unable to do so.

All users of ball bearings must be aware that the inner race very quickly rusts on to the shaft and becomes so firmly fixed that it is often difficult to remove without damaging the ball bearing. So rapidly does this occur that on testing machines in our own shops what looks like red oxide of iron will make its appearance within a few hours, notwithstanding the fact that both the bore of the bearing and the spindle have been well greased, and the shop in which it has been running is a perfectly dry one and kept at an even temperature with hot air. We tried depositing copper upon the bore of the inner race, but this did not stop it, as the rust still made its appearance. Being unable to find a cause for it ourselves, we have asked a large number of people, but have been unable to find anyone who can explain it. In our case this result is found with high carbon steel rings ground out in the bore, but we have found the same thing occur—but to a less extent—with mild steel rings.

Another instance of this effect we have found on a testing machine, which consists of a steel shaft on which we have threaded a number of cast iron discs, weighing as a whole 10 tons. The cast iron discs are clamped together from one end, but the deflection of the shaft causes a slight movement between the discs, and great quantities of red oxide of iron—or what appears to be this, as we have not had it analysed—falls out between the discs.

(The Hoffmann Manufacturing Company, Limited)
Chelmsford, G. F. BARRETT,
December 5th. Director.

DOUBLE-CUTTING PLANING MACHINES.

SIR,—Referring to the notice in THE ENGINEER of November 24th last *re* paper read before the Mechanical Engineers by Mr. J. Hartley Wicksteed, of Leeds, perhaps it may be of interest to many of your readers if I remind them that in your issue of December 3rd, 1880, some thirty-one years ago, they will there find an illustration and full particulars of a patent double-cutting planing machine, which could be used as double cutting with equal traverse of table or as the ordinary planing machine with quick return of table, which was patented and made by the late firm of tool makers, J. and J. Kershaw, of Manchester, with which I was then connected. I may also state that I read a paper on the subject before the Mechanical and Scientific Society, which then held their meetings here, and extracts of which were given in several engineering papers at the time.

Manchester, December 4th. JOHN KERSHAW.

MOTOR COACHES ON THE METROPOLITAN RAILWAY.

SIR,—In your esteemed journal of the 24th November, in your Transport Supplement, you make a statement on page 6 to the following effect:—"The motor coaches on the Metropolitan District lines are fitted with the British Thomson-Houston and Westinghouse Companies equipments." We beg to call your attention to the fact that this is an error, as the equipments on the District Railway and its allied tubes are exclusively B.T.H. Co.

C. L. OECHSNER
(British Thomson-Houston Company, Limited).

Rugby, December 2nd.

LAUNCHES AND TRIAL TRIPS.

STEEL screw steamer; built by Tyne Iron Shipbuilding Company, Limited; to the order of the Northern Commercial Syndicate, Limited, of Newcastle-on-Tyne; dimensions, 342ft. long, 47½ft. broad, by 25ft. 7in. depth; engines, triple expansion, 24in., 40in., 65in. by 42in. stroke, pressure 180 lb. per square inch: constructed by the North-Eastern Marine Engineering Company, Limited, of Wallsend; launch, October 7th.

CLAN MACRAE; built by Wm. Doxford and Sons, Limited, Pallion, Sunderland; to the order of the Clan Line of Steamers, Limited; dimensions, 445ft. long, 53½ft. broad, 29ft. deep; to carry 8500 tons; engines constructed by Doxford and Sons; launch, November 21st.

RODDAM, steel screw steamer; built by the Tyne Iron Shipbuilding Company, Limited; to the order of the Red "R." Steamship Company, Limited, Newcastle-on-Tyne; dimensions, length 342ft., breadth 47ft. 6in., depth 25ft. 7in.; engines, triple-expansion, 24in., 40in., 65in., by 42in. stroke, pressure 180 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Limited; launch, November 22nd.

ARLANZA, triple-screw steel steamer; built by Harland and Wolff, Limited, Belfast; to the order of the Royal Mail Steam Packet Company; dimensions, 600ft. long, 65ft. beam: to carry 15,000 tons; engines, combination reciprocating and turbine; launch, November 23rd.

GOLDENFELS; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Deutsche D.G. Hansa, of Bremen; dimensions, 480ft. long, 58ft. beam; to carry 11,000 tons; engines, four crank quadruple; constructed by Swan, Hunter and Wigham Richardson, Limited; trial trip, November 23rd.

GLENDENE, steamship; built by Irvine's Shipbuilding and Dry Docks Co., Limited; to the order of Milburn, Lund and Co., of Whitby and West Hartlepool; dimensions, 362ft. long, 51ft. 4in. beam, and 26ft. 3in. deep; to carry 6600 tons; engines, triple-expansion, 25in., 40in., and 67in. by 45in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited, of Hartlepool; 11½ knots speed per hour; trial trip, Thursday, November 30th.

DRAYFORD, screw steamer; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Messrs. Wm. Cory and Son, Limited, of London; dimensions, 293ft. 3in. length, 35ft. 3in. breadth; engines, triple-expansion, 19in., 31in., 51in., by 36in. stroke, pressure 180 lb. per square inch; constructed by Geo. Clark, Limited, Sunderland; trial trip, December 2nd.

SINGAN, cantilever framed steamer; built by Sir Raylton Dixon and Co., Limited, Middlesbrough; to the order of Furness, Withy and Co., Limited, West Hartlepool; dimensions, 388¼ft. long, 52ft. broad, and 29¾ft. deep; to carry 7600 tons; engines, triple-expansion, 26in., 44in., 73in., by 48in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co.; trial trip, Saturday, December 2nd.

WINDSOR, steel screw steamer; built by Craig, Taylor and Co., Limited, Thornaby-on-Tees; to the order of Evan Thomas, Radcliffe and Co., of Cardiff; dimensions, 430ft. by 55½ft. by 36ft. 7½in.; engines, 28in., 46in., 75in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Blair and Co., Limited, Stockton; launch, December 6th.

CADMUS, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Messrs. John Gaff and Co., of Glasgow; dimensions, length 289½ft. by 40ft. 2in. by 20ft. 6½in.; engines, triple-expansion, 20½in., 33in., and 54in. by 36in. stroke, pressure 180 lb. per square inch; constructed by Richardsons, Westgarth and Co., Limited, Hartlepool; launch, December 6th.

RUSTON, PROCTOR AND CO'S ANNUAL DINNER.—Nearly seventy persons sat down to the dinner which Ruston, Proctor and Co. gave to their agents and representatives and a few "outside" guests on Wednesday evening at the Waldorf Hotel. The dinner, of course, is now one of the annual events of the Smithfield Club week, and it is invariably a great success, but this year it was not only the largest, but as Mr. Bornemann said, the "jolliest" meeting since the dinner was instituted. The speeches were short, and in them Colonel Ruston and Mr. Bornemann extended a hearty welcome to representatives and customers of the firm who had collected from all quarters of the world. At the conclusion of the dinner an interesting souvenir was handed to each guest. From it we notice that the output of the works to date is 42,800 engines of all kinds, 36,880 boilers, 5200 centrifugal pumps, 600 excavators and 2400 thrashing machines. The firm was established in 1857, and in 1889 was converted into a limited company. In the latter year it paid £99,064 in wages, whereas this year it has paid £361,181, figures which show in a striking way the development of the business. An interesting series of little pictures is given in the souvenir showing how a thrashing machine can be constructed and ready for delivery in twenty-four hours after the receipt of the order.

THE SOCIETY OF ENGINEERS.

THE DESIGN OF TALL CHIMNEYS.

A PAPER on "The Design of Tall Chimneys" was read by Mr. Henry Adams, M. Inst. C.E., on Monday, the 4th inst. The following is an abstract:—

Tall chimneys ought to be designed upon scientific principles, so that there is an absolute guarantee for their stability. The object of the present paper is, therefore, to elucidate these principles and apply them to practice. There are several rules for determining the height of a tall chimney; in some towns 45ft. may be sufficient, but in others 90ft. is the minimum allowed. The height may be determined from the amount of coal burnt, or from the length of boiler and flues. Four different rules are given for the sectional area, depending upon the amount of coal burnt per hour, the fire-grate area, the horse-power of the engine, or a combination of these with the height of the chimney. The shape may be square, octagonal, or circular, the effective wind pressure varying in each case. The author's formula for wind pressure takes account of height and width, increasing with the distance from the ground and increasing also with reduced width. Eight authorities are quoted for the coefficient of pressure for a circular shaft varying from 0.5 to 0.7854. The thickness of the brickwork varies 4½in. every 20ft. in height, but the top length will be from one to one and a-half bricks thick, according to the height and diameter. The minimum batter will be 1 in 48, but this will often be increased by reason of the fire-brick lining in the lower portion. The chimney cap or cornice must not project more than the thickness of the brickwork upon which it rests. The over-all width at base must be at least one-tenth, and if circular at least one-twelfth, of the total height. The fire-brick lining should have a clear space behind it, and no openings should be made in the external wall. After the section is drawn out to suit the conditions, the stability should be calculated at each set-off. The principles of stability can be illustrated by considering a solid square brick pier. The safe load in tension and compression upon various materials is given, and the desirability of an independent foundation is pointed out. The resistance areas of various forms of section and the formulæ for the same, with the method of applying them, are given. Some useful notes are given upon combustion, with the temperature and bulk of the escaping gases, the force of the draught and the horse-power of the chimney.

In an appendix to the paper the author gives the detailed calculations and a design for a chimney 150ft. high and 4ft. 3in. internal diameter, including the concrete base and protection from lightning.

INSTITUTE OF CHEMISTRY.

CEMENT.

MR. BERTRAM BLOUNT delivered his second lecture on "Cement" at King's College on Friday, December 1st, Professor Raphael Meldola, F.R.S., vice-president, occupying the chair. Proceeding to the more practical details of his subject, Mr. Blount pointed out that, owing to our limited knowledge of the chemistry of cement, it was necessary to resort to tests of a physical and mechanical nature in order that the user might be able to satisfy himself that the product he employs would meet the demands laid upon it. From their very nature, such tests must be arbitrary, and, to ensure uniformity, they must be carried out under standard conditions which would satisfy the requirements of the consumer and not lay too heavy a burden on the producer. Mr. Blount was assisted by Mr. Gillett, who demonstrated the method of mixing the cement to be examined, on which so much of the reliability of the tests depends—a point which was illustrated by the story of a firm which undertook to subject a cement to mechanical tests, and reported that a briquette had been made, and had been found to contain a large number of voids.

Mr. Blount remarked that, since cement was not deliberately used under tension, it would appear at first sight to be more logical to appraise its mechanical strength by compressive rather than tensile tests; but, as all the tests were merely used as a basis for comparison, and the errors inherent in compression tests largely invalidated the results, it had become customary to omit them in favour of tensile tests of either the neat cement or of mixtures of cement and sand of a given degree of fineness. Much prominence had been given to the advantage of testing mixtures of cement and sand, on the ground that such a method approximated more closely to the conditions obtaining in actual practice, whilst on the other hand it could equally be urged that the sand prescribed by any standard specification would differ widely both in size and shape from the aggregate usually employed on a commercial scale.

For the user of cement the question of soundness—*i.e.*, the property of remaining constant and unalterable in volume—must always be of paramount importance, and justified the decision of the British Standards Committee in adhering to the simple Le Chatelier test, which had not infrequently been subjected to severe and rather adverse criticisms in some countries. The methods prescribed in the standard specifications of to-day were virtually the same as those laid down some seven years ago, and the quality and uniformity of the modern product had been so well maintained that almost the only alterations had been in the direction of increased stringency, without thereby laying an unreasonable task upon the producer. The information obtained from the ordinary physical and mechanical tests was sufficient for all practical purposes, and probably would not be usefully augmented until some methods were devised for determining the proximate composition of cement and the setting time of concrete. That the former of these had not yet been realised was shown by the fact that, in spite of numerous attempts, no reliable method existed of ascertaining the content of so-called "free lime" in cement.

Turning to the economic side of the subject, it was pointed out that mainly through the introduction of the rotary kiln the cost of production of Portland cement had been so far reduced as to render possible the application of the material to uses in which lime had previously held the field, so that at the present time a limit could hardly be set to its sphere of usefulness. It was shown that whilst theoretically concrete should weigh about 162lb. per cubic foot, the figure found in practice rarely exceeded 140 lb., or in other words, about 14 per cent. consisted of voids—a fact not to be ignored by engineers. This consideration, it was pointed out, at once suggested the possibility of increased economy in construction by using every endeavour to make concrete denser and, consequently, more efficient. Not only might a saving of material be effected thereby, but a further advantage was gained from the fact that the denser product would be less pervious and better able to resist the action of water. It must, it was urged, be borne in mind that water continually exerted a solvent action on cement, and it was obvious that the life of the concrete depended in a large degree on its power of resisting penetration.

For structures of concrete exposed to the action of water, the liberal use of cement was an obvious means of securing imperviousness, but the employment of some substance, *e.g.*, of the pozzolanic class, which would combine with the hydrated lime set free in the process of setting of cement, was perhaps not so common. In the selection of a suitable aggregate not only must its texture be taken into consideration, but also the possibility of any chemical action that it might exert in the concrete; thus débris containing sulphates or easily decomposable silicates was unsuitable. So much had been said of the danger of "magnesia in cement," that the amount allowed had been reduced to quite a low figure. Undoubtedly there had been considerable confusion over this point; the presence of magnesium compounds in structures that had failed under sea-water conditions was really due, not to the presence of magnesium compounds in the original cement, but to the formation of magnesium hydroxide by the reaction of the magnesium salts in sea-water with the lime compounds of the cement.

After thus outlining a few of the intricate problems that might be presented to the technical adviser, Mr. Blount sketched out a course of training for those who intended to specialise in the subject. After a broad elementary education, he insisted on a sound general knowledge of chemistry, supplemented if possible by some mechanical and engineering training, before attempting to proceed to a post-graduate training in the chemistry of cement. This should be gained in a laboratory within easy reach of some centre of the industry where access to works could be obtained, in order that the student might be able to free himself from the small details of laboratory practice and grasp the broad principles, technological and economic, that underlay success in any chemical manufacture.

In conclusion, Mr. Blount briefly reviewed the present position of our knowledge of the chemistry of cement, and paid a high tribute to the valuable results achieved many years ago by Le Chatelier, which, he explained, remained but slightly modified to-day.

FORTHCOMING ENGAGEMENTS.

TO-DAY.

ROYAL ASTRONOMICAL SOCIETY.—Burlington House, W. "The New Synchronome Astronomical Regulator," Mr. F. Hope-Jones. 5 p.m.

BRITISH FOUNDRYMEN'S ASSOCIATION.—Cannon-street Hotel. "Solidification of an Iron Casting in the Mould," Professor T. Turner, of Birmingham. 8 p.m.

ASSOCIATION OF WATER ENGINEERS.—Geological Society's Apartments, Burlington House, W. Special general meeting for the purpose of transacting special business, and, if thought fit, passing resolutions. 3.30 p.m.

THE ROYAL AUTOMOBILE CLUB.—Pall Mall, S.W. "London to Brighton in Forty-five Minutes by Electric Train," Mr. Philip Dawson. The lecture will be illustrated by lantern slides and cinematograph films. 9 p.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—Clerkenwell. The Annual Prize Distribution and Students' Conversazione. Sir William H. White will distribute the prizes and certificates. On Saturday the Conversazione will be continued. 6.30 to 11 p.m. both evenings.

FRIDAY, DEC. 8TH, AND SATURDAY, DEC. 9TH.

THE INSTITUTION OF WATER ENGINEERS.—Geological Society, Burlington House, W. First winter general meeting. Friday at 4 p.m., Saturday 10.15 a.m. For programme see page 577.

SATURDAY, DECEMBER 9TH.

BRITISH FOUNDRYMEN'S ASSOCIATION.—Holborn Restaurant. Annual Dinner.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Sixth Annual Dinner will be held at the Trocadero Restaurant, Piccadilly Circus, W. 7 for 7.30 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Wood Memorial Hall, Newcastle-upon-Tyne. The following papers will be open for discussion:—"The Advantages of Freezing as a Method of Sinking through Heavily-watered or Difficult Ground," Mr. William Brumwell Wilson. "Experiments on Liquid Mixtures for Laying Coal-dust," Prof. W. M. Thornton, D.Sc., D.Eng. "The Holmes-Ralph Gas-detecting Portable Electric Lamp," Mr. George J. Ralph. "The Microscopical Examination of Coal, and its Use in Determining the Inflammable Constituents Present therein," Mr. James Lomax. 2 p.m.

MONDAY, DECEMBER 11TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 3, "The Carbonisation of Coal," Professor Vivian B. Lewes. 8 p.m.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. "Wireless Telegraphy," with demonstrations, Mr. John McLaren. 8 p.m.

THE INSTITUTE OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W. "The Standardisation of Vitrified Ware Pipes," Mr. James Farley. 8 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—Storey's-gate, St. James's Park, Westminster, S.W. "Printing Press and Kindred Machines," Mr. R. H. Briggs. 8 p.m.

CLEVELAND INSTITUTION OF ENGINEERS.—In the Hall of the Cleveland Literary and Philosophical Society, Corporation-road, Middlesbrough. Paper to be read and discussed, "Some Modern Developments in the Electrical Driving of Rolling Mills," Mr. C. Antony Ablett. 7.30 p.m.

THE ROYAL SCOTTISH SOCIETY OF ARTS.—117, George-street, Glasgow. Communication, "On the Fire at the Empire Theatre, Edinburgh, and its Relation to the Construction of Theatres from the Point of View of Public Safety," with Lantern Illustrations, Mr. Arthur Pordage, Firemaster, Edinburgh. 8 p.m.

TUESDAY, DECEMBER 12TH.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Annual Dinner.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. "Should Exhaust Steam be Wasted?" Mr. P. Barrett Coulston. 4 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. "Experiments on the Strength and Fatigue Properties of Welded Joints in Iron and Steel," Dr. T. E. Stanton and Mr. John Robert Pannell. 8 p.m.

WEDNESDAY, DECEMBER 13TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. "Continuous Service in Passenger Transportation," Mr. W. Yorath Lewis. 8 p.m.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's-gate, S.W. "Engine Design for Taking Advantage of Horse-power Rating," Mr. L. H. Pomeroy. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—The Institution of Electrical Engineers, Victoria Embankment, W.C. Lecture on "Steel Specifications considered Commercially," Major H. B. Strange, of Sheffield. 8 p.m.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Methods of Dealing with Losses in Steam Plant due to Condensation," Mr. Geo. Wilkinson and Mr. J. Rendell Wilkinson. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.—Room 167, Technical School, Suffolk-street, Birmingham. "Automatic Starting of Asynchronous Motors," Mr. N. Pensabene-Percy. "Some Notes on the Circle Diagram," Mr. T. F. Wall. To be followed by an Oscillograph Demonstration of above starting apparatus, and a Demonstration by Dr. Kapp of a Magnetic Apparatus for Testing the Endurance of Metals under often Repeated Stresses. 7.30 p.m.

THURSDAY, DECEMBER 14TH.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment, W.C. "Residence Tariffs," Mr. A. E. Seabrook. 8 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Indian Section. "Fisheries of Bengal," Mr. J. Travers Jenkins. 4.30 p.m.

THE CONCRETE INSTITUTE.—Denison House, 296, Vauxhall Bridge-road, Westminster, S.W. Ordinary general meeting. Paper, "Some Recent Works in Reinforced Concrete," Mr. G. C. Workman. 8 p.m.

FRIDAY, DECEMBER 15TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. "Tests on Reinforced Concrete," Mr. E. F. Hunt. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. Ordinary general meeting. Discussion upon "Double-cutting and High-speed Planing Machines," Mr. J. Hartley Wicksteed. Paper to be read and discussed (if time permits), "Oil-burning Locomotives on the Tehuantepec National Railway, Mexico," Mr. R. Godfrey Aston. 8 p.m.

SATURDAY, DECEMBER 16TH.

THE STEPHENSON SOCIETY.—Visit to the Central London Railway's Works and Generating Station at Caxton-road, Shepherd's Bush. Meet at Shepherd's Bush Station, 3 p.m.

MONDAY, DECEMBER 18TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 4, "The Carbonisation of Coal," Professor Vivian B. Lewes. 8 p.m.

TUESDAY, DECEMBER 19TH.

PHYSICAL SOCIETY OF LONDON.—Annual Exhibition at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Afternoon and evening.

SATURDAY, DECEMBER 30TH.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. Social Evening for the Junior Section. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Boiler Shop Design," Mr. W. J. Bennett. 6.45 p.m.

FRIDAY, JANUARY 19TH, 1912.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Halls, Glasgow. The "James Watt" Anniversary Dinner.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

A Good Outlook.

THE outlook continues favourable up to the close of the year and also for the first quarter of 1912. The works are well engaged upon the quarterly contracts last taken, which are now getting towards completion. A little additional business is being booked, but consumers appear for the most part to have satisfied their requirements for the present. Meanwhile, values are well upheld, with a tendency towards further advancement. The various engineering industries are actively engaged and are using large quantities of iron and steel, and seem likely to continue well occupied for several months ahead. Large and important orders are held by motor-car builders and by steam, gas, and oil engine builders; also by electrical engineers for lighting and power plants. The hydraulic engineering industry is busy on irrigation requirements for abroad and upon water supply account for home. Boilermakers have some good work in hand. The tube trade is busy in nearly all branches, but competition continues very severe.

Pig Iron.

The blast furnaces are making large outputs, none of which is going into stock; indeed, the requirements of customers are almost greater than can be punctually met. Smelters are, however, doing their best to make deliveries regularly both to forges and foundries. Values are firmly maintained, and for additional business to the large quantity already booked considerable premiums are asked upon current quotations. Staffordshire forge is quoted 49s. upward, part-mine 50s. 6d. to 51s. 6d., best all-mine forge 80s., foundry 87s. 6d., and cold blast 115s. Midland descriptions are also in very good request, and exhibit an onward tendency in value, Northampton being quoted 50s. to 51s. and upward, and Derbyshire 51s. 6d. to 52s 6d. The pig iron market generally continues to be supported by the dearness of fuel.

Manufactured Iron.

There is a large consumption going on of all descriptions of manufactured iron, deliveries being soon used up. Marked bars are quoted £8, unmarked £6 15s. to £6 17s. 6d.; black sheets (doubles) £7 15s. to £7 17s. 6d., and galvanised corrugated sheets £11 to £11 7s. 6d. Hoops are being rolled in fair quantities, and are quoted £7. Slit nail rods are £7 15s., and gas strip is £6 12s. 6d. to £6 15s.

Steelmakers Busy.

A brisk business has recently been transacted in steel, both crude and finished, and the works are now very busy. Bessemer sheet bars are quoted £5 2s. 6d. and Siemens £5 5s. Structural engineers are good customers for sections. Angles are quoted £6 12s. 6d. to £6 15s.; girder plates, £6 2s. 6d. to £7 5s.; ship plates, £7 to £7 10s.; and joists, £6 10s. A meeting of British steel merchants held in Birmingham on November 30th, which was of a private character, induced expressions of opinion by some of those present that the new rebate system ought to be tested in the law courts as being in restraint of trade, but others were in favour of allowing the scheme to proceed. It was pointed out that legal proceedings would be long and costly, as in the case of the shipping rings some years ago, and that there was no certainty as to the issue. It is understood that no definite course was decided upon.

Midland Iron and Steel Wages Board.

The net average selling prices of all classes of iron for September and October have been announced by the Midland Iron and Steel Wages Board as £6 10s. 4d., which is better than the last return, but not sufficiently so to alter wages, which remain at 8s. 9d. per ton for puddling. The new average compares with £6 8s. 11d. in the two preceding months, with £6 7s. 2d. a year ago, and with £6 3s. 9d. two years ago. The sales of the seventeen selected firms are also considerably better, having amounted to 45,462 tons, compared with 34,884 tons in July and August; 33,687 tons a year ago; and 37,322 tons two years ago. The increased production was chiefly due to the larger output of bars, which amounted to 30,129 tons, against 21,902 in the previous return. The improvement in the bar trade has made further progress since October, and the next return will probably show a still larger output, and should give the ironworkers an increase in wages.

Extension of Electricity Works.

At a recent meeting of the Burton-on-Trent Electricity Committee, the engineer, Mr. T. Hull, presented a report in which he recommended an extension of the electricity works of the Corporation at an expenditure of £17,000. It was pointed out that this was rendered necessary by the increased volume of trade, which showed signs of still greater improvement. The present plant is to be duplicated, and additional machinery put down to link up with the present engines. The scheme will provide for the taking of a maximum load equivalent to 1250 kilowatts, which is the same capacity as the new turbine generating plant which it is proposed to instal in the place of the present No. 1 generator, the capacity of which is only 80 kilowatts. The proposal is to be placed before the Town Council at its next meeting.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Improving Prospects.

WHILE the attendance on the Iron Exchange on Tuesday was below the average, there is a much stronger tone to note, and sellers generally showed a disposition to ask higher figures. English and Scotch brands ruled very firm, and in the former Derbyshire showed an advance of about 6d. per ton. Scotch was in sellers' favour, especially Eglinton, which was dearer. West Coast hematite was about 6d. and East Coast 1s. per ton higher. While there is no change to note on spot in finished iron, Yorkshire bars have been advanced 5s. per ton. It is expected, however, that this district will come into line within the next two or three weeks. Steel steady. In copper, tough ingot and best selected were dearer, and both sheet, lead, and tin ingots much firmer.

Quotations.

Pig iron: **Lincolnshire, No. 3 foundry**, 54s. to 54s. 6d.; **Staffordshire**, 55s.; **Derbyshire**, 55s. to 55s. 6d.; **Northamptonshire**, 55s. 4d.; **Middlesbrough**, open brands, 57s. 4d. to 57s. 10d. **Scotch**: Gartsherrie, 63s. 6d. to 64s.; **Glengarnock**, 61s. 6d. (official, 62s.); Eglinton, 61s. to 61s. 6d., **delivered Manchester. West Coast** hematite, 65s. to 65s. 6d.; **East Coast** ditto, 63s. 6d. to 64s. 6d., both f.o.t. **Delivered Heysham: Gartsherrie**, 61s. 6d. to 62s.; Glengarnock, 59s. 6d. (official 60s.); Eglinton, 59s. to 59s. 6d. **Delivered Preston: Gartsherrie**, 62s. 6d. to 63s.; Glengarnock, 60s. 6d. (official 61s.); Eglinton, 60s. to 60s. 6d. **Finished iron: Bars**, £7; hoops, £7 7s. 6d.; **sheets**, £8 to £8 2s. 6d. **Steel: Bars**, £6 15s. to £7 5s.; **Lancashire hoops**, £7 7s. 6d.; Staffordshire ditto, £7 7s. 6d.; sheets, £8 to £8 5s.; boiler plates, £7 17s. 6d. to £8; plates for tank, girder, and bridge work, £7 5s. to £7 7s. 6d.; English billets, £5 5s. to £5 7s. 6d.; foreign ditto, £4 18s. to £5; cold drawn steel, £9 5s. to £9 10s. **Copper: Sheets**, £75; tough ingots, £62 15s. to £63 5s.; best selected, £63 10s. to £64 per ton; copper tubes, 9¼d.; brass tubes, 7¾d.; condenser, 8¾d.; brazed brass tubes, 8¾d.; rolled brass, 7d.; brass wire, 7d.; brass turning rods, 7½d.; yellow metal, 6¼d. to 6⅝d. per lb. **Sheet lead**, £19 5s. to £19 7s. 6d. per ton. English tin ingots, £204 per ton.

The Lancashire Coal Trade.

The tone on the Coal Exchange on Tuesday ruled quiet, and the attendance was about a normal one. There were few features of interest to note in house coal, but the colder weather now being experienced will no doubt tend to stimulate business in this department. In slack and engine fuel there was, if anything, a rather weaker feeling to note, and prices for immediate delivery were a shade lower. Trade in the shipping department continues well up to the average.

Petrol Tramways for Morecambe.

The first petrol-driven tramcars to be used in this country will shortly be substituted by the Morecambe Tramway Company for the horse cars now in use between Morecambe and Heysham. This company was one of the first to appreciate the advantages of electric traction for tramways, but the local authorities would not permit the electric system to be adopted. During the past year the expenses of the horse-hauled tramcars amounted to 13.63d. per car mile and the receipts 15.20d. per car mile. The new cars are being built by Leyland Motors Limited, and will have an excellent opportunity of demonstrating an economy compared with the horse system.

Manchester Association of Engineers.

The quarterly meeting of this Association will be held at the usual place to-night (Friday), when a paper will be read by Mr. J. A. Weil on "Producer Gas and its Application to the Economical Generation of Power." I am glad to be able to report that the president, Mr. Michael Longridge, is making excellent progress to recovery from his severe illness.

Manchester Ship Canal Charges.

The Manchester Ship Canal Company has given notice that on and from January 1st next there will be an increase in the existing rates for quay porterage, warehousing, storage in the open, and that rent on merchandise and minerals will also be increased. The existing charges on timber and cotton will continue without alteration for the present. The revised scale of charges is largely the outcome of the increased expenditure consequent upon the recent labour disputes.

Developments in the Salt Trade.

At a meeting of the River Weaver Trust held last week it was stated that the gross income of £52,695 was larger than in any year since the reconstruction of the Trust in 1895. The increased revenue was due to an additional output of white salt of 60,000 tons, 20,000 tons of chemicals, and 13,000 tons of pottery materials. Mr. G. H. Cox, chairman of the Salt Union, said the Weaver was a splendid waterway, but ought to be extended to the potteries and perhaps to Birmingham. He said if the county councils and other local bodies would take their courage in their hands and free the river from all tolls, new industries would spring up on its banks.

The Cotton Trade.

November was a very good month for the staple industry. The variations in the prices of cotton have been insignicant, but there are predictions of lower prices ahead owing to the estimates of the American crop pointing to the largest on record.

Gas-fired Furnaces at the Mint.

After extensive experiments with oil-fired and gas-fired furnaces the Royal Mint authorities have adopted the burners of Mr. S. N. Brayshaw, Manchester. The gas is taken at the ordinary pressure in the main (about 3in. of water) and mixed with air from a powerful blowing engine at about 2 lb. pressure. With care the noise of these burners can be reduced sufficiently to be unobjectionable, the furnace linings compare very favourably with those hitherto used for coke with regard to endurance, and the crucibles used for gold are found to last longer, each crucible serving for an average of 18 heats as against 12 when coke is used. According to the Royal Mint report for 1910, the adoption of gas as a fuel in place of coke has been accompanied by several incidental economies, and it is interesting to note that the present charge for fuel averages about 4½d. per cwt. of standard gold bullion as against 7d. when coke was used. It should be added that in this statement the fuel needed to warm up the furnace in the morning has been eliminated, but, including this, the cost rarely exceeds 5d. per cwt. on a day's work. During 1910 the Mint installed 16 gas-heated furnaces, each capable of taking a 400 lb. crucible, and fired with Brayshaw gas burners. These 16 furnaces have a maximum capacity of 2⅔ tons of sterling silver, or 2½ tons of bronze per melt, and four melts of silver, or three of bronze, can be made in an ordinary working day (8 a.m. to 6 p.m.) Also five furnaces similarly gas heated, but of a smaller size, are in use for melting gold.

BARROW-IN-FURNESS, Thursday.

Hematites.

The condition of the hematite pig iron trade is one of steadiness. The amount of business being done by makers is not very large at present, but is a shade larger than of late. At the same time, there is a better feeling all round, and a strong hope is expressed that very shortly a much brisker demand for iron will assert itself. Just now local steel makers both in Cumberland and North Lancashire are taking fairly large supplies of iron, particularly in the Workington district. Outside some pretty good deliveries of iron are being made by those who smelt for the open market. Of course, the volume of iron produced is not by any means big, for many furnaces are standing idle. Thus the Millom Company has only a third of its plant working, the whole of its Askam Works standing idle. The iron made is all being disposed of, and it may happen that the output will be increased in the New Year. Makers are quoting 64s. to 65s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron. For special sorts of iron there is a steady call, the price running up to 70s. per ton. Warrants are quoted by sellers at 63s. 4½d. per ton net cash, but no business is being done.

Iron Ore.

The iron ore trade, on the whole, is pretty well employed. There is marked activity in the Cumberland district, particularly at Hodbarrow and Cleator Moor, but at the Lindal Moor Mines there is rather less activity, and some men were discharged last week end. The Park and Roadhead Mines, near Barrow, are busy. The demand from outside sources is well maintained, and good average sorts are at 10s. to 12s., with best classes of ore at 20s. per ton net at mines. Spanish ores are in steady request at 20s. per ton delivered for best qualities. A cargo of Irish ore was brought into Barrow last week.

Steel.

There are no new features to report in this trade. A good output of rails is being maintained mostly for colonial buyers from the Barrow works and also by the Cumberland Steel Combine. The demand for rails remains much the same, with plenty of room for improvement, and heavy sections are quoted at £5 12s. 6d. to £5 15s. per ton. There have been some fair deliveries of rails on Barrow docks for shipment to Adelaide; two Clan Line steamers taking part cargoes, finishing their loading at Glasgow and Liverpool. Tin bars have been receiving some attention for coastwise shipment from Barrow. Steel shipbuilding material is in brisk demand.

Shipbuilding and Engineering.

The Chinese training cruiser, Ying Swei, built at Barrow, has just completed successful trials, steaming 24½ knots on the measured mile. All departments at Barrow are busy.

Fuel.

There is a steady demand for coal in this district, and good steam sorts are quoted at 12s. to 16s. per ton. Coke is in pretty good demand, with East Coast sorts at 20s. 6d. per ton delivered.

Shipments.

The shipments of pig iron last week were 1756 tons, and steel 10,086 tons, a total of 11,842 tons, and an increase on the week of 936 tons. The shipments this year stand now at 453,317 tons, a decline of 182,026 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

General Conditions.

CONTINUED activity is reported at the local works, full time, and in many cases overtime, being the rule in practically all departments. In a great measure the pronounced revival in the steel trades is due to the heavier weight of orders on railway account, both at home and abroad. During the past two or three years railway material of all kinds had been in reduced demand following the collapse in trade in 1907, but the sharp recovery since then has caught the home railways short of stores and rolling-stock and engines. Orders are now coming in steadily, and with a larger programme of railway construction in various parts of the world, makers of railway materials of all kinds believe themselves assured of good employment for a considerable time ahead. Armament material is another of the exceedingly active branches, but, unlike railway material, has been so all through the year. All the armament companies are working at almost full pressure. The same report is given of conditions in the lighter steel branches, high-speed steel, engineers' and agricultural tools, implements, files, edge tools being in brisk demand on home account, and the foreign and colonial orders are once again expanding. There is a larger volume of trade than for some years past in the stove grate industry. Cutlery and plate makers are enjoying a remarkably active Christmas trade, and a scarcity of skilled workmen is reported. Manufacturers, however, while well satisfied with the orders coming to hand, report that selling prices are low in comparison with the costs of production, which, moreover, show an upward tendency.

The Coal Trade.

The steam coal market remains very firm, despite the lessened tonnage going into shipment. The industrial consumption is the chief factor now, and an exceptionally heavy tonnage is being taken, whilst the railway companies also are consuming more than average supplies. Colliery stocks are practically non-existent. We understand that tenders have been sent in to several of the big railway companies quoting 10s. 6d. per ton at pits for the renewal of contracts for South Yorkshire best hards. This is an advance of 1s. 6d. per ton on present contract prices. As we have already stated, the market is of opinion that the contracts will be renewed on the basis of 1s. to 1s. 3d. per ton advance, and, in view of the new mines legislation, this advance is considered very reasonable. Current market prices are 9s. 6d. to 10s. per ton.

Coke.

Blast furnace coke is again harder in tone, 12s. 3d. to 12s. 6d. per ton being readily obtained for three months' contracts. The demand is very steady, and there is every indication of further expansion.

Slacks.

Contracts for slacks continue to be freely renewed at advances of 6d. to 9d. per ton above the old contracts which expire at the end of the year. The current demand is strong and difficult to meet, especially so in the case of best sorts, which are slightly dearer. Current quotations:—Best washed smalls, 6s. to 6s. 6d.; best hard slacks, 5s. 9d. to 6s.; seconds, 4s. 3d. to 5s.

House Coal.

Practically no change can be reported in the condition of the house coal market. Prices remain steady, and, if anything, the demand is slightly better as the result of the colder weather. Collieries are not forcing sales. Production is interfered with by the scarcity of empty wagons.

Pig Iron.

The local trade in pig iron has shown renewed buoyancy, with prices substantially higher. This is largely due to makers holding off the market. Their quotations are now several shillings above the rates at which local consumers booked heavily a short time ago. Lincolnshire sellers ask fully 2s. above the official basis rates given below, and some makers of Derbyshire iron are off the market. There is a general indisposition to sell, as the production in many cases is scarcely up to current requirements. Hematites are in the same position, makers quoting from 72s. to 74s. per ton net delivered here for East Coast qualities, the latter price being for forward delivery. Current quotations:—Lincolnshire, No. 3 foundry, 50s. 6d.; ditto, forge, 49s. 6d.; ditto, basic, 52s.; Derbyshire, No. 3, 50s. 6d. to 51s.; ditto, forge, 48s. 6d. to 49s. 6d., all per ton delivered Sheffield or Rotherham. Hematite prices are:—East Coast mixed numbers, 72s. to 73s. net; West Coast ditto, 77s. to 78s., less 2½ per cent. discount. Bar iron, £7 5s.; and hoops, £7 5s. The billet trade is very active, and prices remain: Siemens, £7 5s. to £7 10s.; basic, £5 5s. to £5 10s.

Bar Iron Again Higher.

At a meeting of the South Yorkshire Bar Iron Association on Monday it was decided to raise prices by another 5s. per ton, making an increase of 10s. during the current quarter. The price of bar iron is now £7 5s. per ton. The mills are full of work.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

WHILE the warrant market is somewhat weak and sensitive, prices fluctuating rather erratically, the general market for pig iron continues, on the whole, very satisfactory, and quotations are well maintained. Makers are in a satisfactory position as regards orders, and having only small stocks they can afford to wait for better prices, and do not pay much heed to the easier rates for warrants, which came at intervals. Cleveland warrants at the close of last week attained 48s. 1d. cash buyers, the highest price that had been reported since last March. This tempted some speculators to sell out to realise profits, with the result that their operations have weakened prices this week, and on Wednesday 47s. 7½d. cash was all that would be given. This is surprising in face of an almost unprecedented decrease in the stock of Cleveland pig iron in Connal's public stores—4376 tons in the first four working days of December—and of the extraordinary shipments of pig iron from the district—28,569 tons this month to 5th, against 10,559 tons in November to 5th. When it is considered that December is one of the quietest shipping months of the year, such a record of exports is particularly noticeable, more especially the shipment of no less than 14,334 tons on Monday, almost, if not quite, the largest shipment on record for one day. Such statistics as these indicate great activity in the pig iron trade, and show that there is nothing in legitimate trade to justify any weakness in prices. Makers are in some cases realising 49s. and 50s. for early f.o.b. deliveries of No. 3 Cleveland pig iron, but 48s. is the general price, and a good deal has been sold also at 48s. 3d. No. 1 is at 51s. 9d., No. 4 foundry at 47s. 6d., No. 4 forge at 47s. 3d., and mottled and white at 47s., all for prompt delivery, with 1s. per ton more for delivery over the first quarter of next year. The cost of production is substantially increasing for pig iron, for lately foreign ore has in the aggregate risen nearly 2s. per ton, while coke is up by quite that amount. The advances in prices of pig iron cannot be considered adequate, for Cleveland iron has gone up about 2s. 6d., and East Coast hematite about 2s., but the tendency of prices of pig iron is undoubtedly upwards.

Hematite Pig Iron.

The advances in the prices of East Coast hematite pig iron have rather stimulated the demand for it, and there has been a good deal of buying, especially by home consumers, who, themselves, are doing well, and are likely to find business even better than it is. The advances in the prices of hematite pig iron are due not only to the brisker demand, but also to the increasing cost of production, for all the materials used in pig iron making have risen in price. There does not seem any chance of quotations being lower, and, therefore, consumers have become keen to buy, and for delivery over the whole of the first half of 1912. Satisfactory contracts are on the books of producers, and they have been able to maintain the upward movement without any "set backs," thus being put in a better position than the makers of Cleveland pig iron, who have to withstand the competition of warrants. The price of East Coast hematite pig iron has risen 2s. per ton within a month, and it is generally acknowledged that this is justified by the actual condition and prospects of trade, and speculative operations play no part in bringing about the improvement. Mixed numbers have been put up to 62s. 6d. per ton for December delivery, 63s. for January, 63s. 6d. for February-March, and 64s. for spring delivery. The further the delivery forward, the more has to be paid.

Ironmaking Materials.

All the materials used in the production of pig iron are being advanced in price, and the demand has become brisk all round. Several cargoes of Rubio ore have been sold for prompt delivery Middlesbrough at 22s. per ton, but for delivery over the first half of next year 21s. 6d. per ton is the figure that has to be paid, and 22s. is offered for delivery over the second half of the year. This compares with 20s. to 20s. 6d. which was being asked early in the autumn season. Merchants must have higher rates to recoup them for the greater prices quoted by the Spanish mine-owners and for the heavier rates of freight. The rate from Bilbao to Middlesbrough a few months ago was only 4s. 3d. per ton; now it is fully 6s. 6d., and steamers are not readily forthcoming even at that. Shipowners are not keen on letting their steamers carry ore if other cargoes can be secured. Coke prices are going up with a run, and consumers are anxious to purchase for delivery over next half-year, and even further ahead. Coke, from being too plentiful, as it was in August and September, is now scarce; in fact, the demand is in excess of the supply. Coal is in such pressing demand and such high prices are offered for it that owners are selling a good deal of coking coal as coal, it paying them better to do that than to convert it into coke; and so the supply to the ovens is short. Consumers have to pay for furnace coke of medium quality quite 16s. 6d. for next half-year's delivery, and even 17s. is asked; thus there has been a rise of fully 2s. per ton within the last month, and further advances are looked for. Limestone has been advanced to 4s. 6d. per ton, delivered at Middlesbrough furnaces, and increased deliveries are reported.

Further Substantial Decreases in Pig Iron Stocks.

One of the most prominent features of the pig iron market, and one which has an important influence in assisting the rise in values that is in progress, is the steady decrease in the stock of Cleveland pig iron in the public stores. The return issued by Messrs. Connal and Co. as to the stock in their public warrant stores at the end of November was the best for any month for over four years. The stock at November 30th was 557,019 tons, that showing a decrease for the month of no less than 20,501 tons. Between June, 1908, and July, 1911, there was not a single month which showed a decrease, and the stock ran up from 48,000 tons to 601,473 tons; but August, September, and October, as well as

November, have exhibited decreases, the stock being nearly 50,000 tons less than at the recent maximum. Makers' own stocks are likewise being substantially reduced, and now are very small.

Manufactured Iron and Steel.

Business continues most satisfactory in all branches of the manufactured iron and steel industries, and prospects are good, more especially for those who produce rails, plates, angles, and galvanised sheets. The production in these branches was never so large as it is at present. Prices are all firmly maintained, and at figures which afford a fair amount of profit. For steel ship plates £6 15s. is quoted, for iron ship plates £6 10s., for steel ship angles £6 7s. 6d , and for iron ship angles £7, all less 2½ per cent., delivered at the shipyards on the North-East Coast; these rates being subject to a rebate of 5s. per ton where the consumer buys all he requires from association firms. Steel bars are at £6 5s., iron bars at £7, steel hoops at £6 12s. 6d., steel strip at £6 10s., steel joists at £6 10s., steel sheets at £7 7s. 6d., iron ship rivets at £7 5s., all less 2½ per cent. f.o.t. Galvanised and corrugated steel sheets, 24 g., are at £11 5s. less 4 per cent. f.o.b.

Shipbuilding.

Shipowners are having an uncommonly good time, freights having gone up very rapidly. The number of vessels now offering for the work of transport is hardly equal to the demand, and, even at the present high freights, it is difficult to charter boats. This situation puts owners in a mood for ordering new steamers, and there is a good inquiry for them, notwithstanding that shipbuilders have advanced their prices rather substantially. Among the important orders just placed in this district it may be remembered that the Cunard Company has given an order to Swan, Hunter and Wigham Richardson, Wallsend-on-Tyne, for a steamer of 10,000 tons deadweight capacity for its Canadian service. R. and W. Hawthorn, Leslie and Co., Hebburn-on-Tyne, have booked an order for one of their patented ore-carrying steamers of about 10,000 tons deadweight capacity for Mr. P. A. Weilin, of Stockholm. The builders have made a speciality of this type of vessel for several years, and have built a considerable number for Swedish owners. The owners of the Leyland Line have also ordered from Messrs. Hawthorns another steamer, making the fourth that these builders have in hand for the same owners.

Railway and Other Extensions on Teesside.

In 1903 the North-Eastern Railway undertook that within the next ten years it would construct a new railway from Stockton to Billingham Creek, on the north bank of the Tees, to connect with a railway already laid down between the last-named point and Haverton Hill and Port Clarence. On the strength of that promise the landowners, at a cost of £22,000, made a highway along the north bank. But no move has yet been made by the railway company to carry out its undertaking, and the Tees Conservancy Commissioners have decided to press upon it the necessity for proceeding with the work. It is held that until the railway is made there is little likelihood of manufacturers or others who want to establish works in the district making use of the land on the north bank. The railway company, it is said, is waiting till new works are projected near the site of the new line.

Engineering.

Referring to a proposed combination of engineering firms, Lord Furness, at a meeting of the shareholders of Richardsons, Westgarth and Co., Limited, on Saturday, at West Hartlepool, remarked that "trade is now admittedly good, shipyards are full of orders, freights are most satisfactory, yet the energies of engine builders are concentrated on a game of 'beggar my neighbour.' They refuse to act in accord, and in consequence they have to see contract after contract carried out at a loss. If the engine builders would meet together in friendly conference it might be possible to follow the example of other manufacturers who have found themselves in a similar predicament, and who, by combined effort, have preserved both their industry and their capital." The Blake Boiler, Wagon, and Engineering Company, Limited, Darlington, has booked an order for fifty bogie flat-bottomed 20-ton wagons for the Antofagasta (Chile) and Bolivia Railway. It has also secured the contract for seventy 19-ton all-steel bogie covered wagons for Nigeria, and for 600 pairs of wheels and axles for the Ceylon Government Railways, as well as for 100 pairs for the Madras and Southern Mahratta Railway. It is reported that a North of England firm is about to commence the manufacture in the district of edged tools, such as picks, shovels, &c., and is now searching for a site.

Utilisation of Slag.

For some years blast furnace proprietors who could not secure land on which to deposit their slag have had to send it to sea, and deposit it at a point five miles from the mouth of the Tees at heavy cost, for it had to be conveyed in some cases over fourteen miles. It is now proposed that, instead of being sent to sea, the slag shall be utilised for filling up the hundreds of acres which the Tees Conservancy has reclaimed from the river, and thus make the ground available as sites for works.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

Continued Activity in Warrants.

A large business has been done this week in pig iron warrants on Glasgow Exchange, a fresh stimulus being given to the market by the decided improvement advised in the American iron and steel trades. The interest of consumers and operators has also been heightened by the expansion of the volume of transactions. It is quite usual now for as much business to be done in one day as earlier in the year occupied the attention of brokers for about a week. Reactions have come in prices, as was inevitable, but the broadening of the market affords opportunities for business that were not formerly available. A considerable proportion of the iron purchases in the past week or two has been for delivery in the early part of the coming year. The reduction of stocks which has been proceeding at Middlesbrough has been a helpful feature in the business. On the other hand, the "bear" interest has taken advance of the report that the German Pig Iron Syndicate has decreed the ultimate total elimination of British pig iron from the German market. No doubt this matter is of importance in view of the large extent to which our merchants have been in the habit of dealing with Germany, but reliable information is wanting as to the power of the Syndicate to put such a policy into force. The business in Cleveland warrants since last report has been at 47s. 5½d. to 48s. 1½d. cash, 47s. 9d. to 48s. 5d. one month, and 48s. 4½d. to 49s. three months, 48s. 10d. being also paid for delivery on 29th February. Cleveland pig iron has been in good demand in Scotland, and the past week's arrivals amount to 16,473 tons, being 827 tons more than in the corresponding week of last year.

The Scotch Pig Iron Trade.

The upward movement in warrants and also in the prices of Scotch pig iron has brought out a good deal of fresh business in G.M.B., and also in the special brands of Scotch pig iron. Local consumers have been purchasing more freely, and there has been more buying on English account as well as for export. There are 84 furnaces in blast in Scotland, compared with 86 at this time last year. Govan and Monkland are quoted f.a.s. at Glasgow, Nos. 1, 57s.; Nos. 3, 56s.; Carnbroe, No. 1, 61s.; No. 3, 57s.; Clyde and Calder, Nos. 1, 63s.; Nos. 3, 58s.; Summerlee and Langloan, Nos. 1, 64s.; Nos. 3, 59s.; Coltness, No. 1, 82s. 6d.; No. 3, 59s.; Eglinton, at Ardrossan or Troon, No. 1, 56s. 6d.; No. 3, 55s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 58s.; No. 3, 56s.; Shotts, at Glasgow or Leith, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Carron, at Grangemouth, No. 1, 64s.; No. 3, 59s. per ton. The shipments of pig iron from Scotch ports in the past week amounted to 7873 tons, being 3856 tons more than in the corresponding week of 1910. While these figures indicate an expansion in the shipments compared with what has been usual recently, ironmasters and merchants state that shipment business has suffered owing to increased freights.

The Hematite Trade:

There has been a moderate business in hematite pig iron. Cumberland warrants have been in less demand. Holders offered to sell at 63s. 6d. for delivery in one month, without finding purchasers. Makers' prices here and in the North of England are firm. Business is reported to have been done in Scotch hematite for future delivery at 66s. 6d., and the cash quotation is now 66s. for delivery at West of Scotland steel works. Spanish ore is quoted 21s. 6d. to 22s. for delivery at Glasgow during the next three months. Current consumption of hematite pig iron is on an extensive scale, and there appears every prospect of a continuance of good business.

Finished Iron and Steel.

There is full employment at most of the malleable iron works, with a fair business offering. So far, there does not appear to be much, if any, improvement in prices. The current business is reported on the basis of £6 to £6 2s. 6d. for crown bars, less the usual 5 per cent. discount for delivery in Clyde district. Foreign inquiry is fair, and there is less competition on the part of continental makers. Makers are anxious to raise prices, because of the advance in raw material here and of finished iron in the South; but they find this difficult in the absence of a combination, and hints are given that there may ere long be a resuscitation of the association for this purpose. In the steel trade there is a very large business being done. Most of the works are fully employed, and the output of material is said to be about the largest that has ever taken place. The deliveries of shipbuilding material are heavy and the foreign business is of substantial importance. Inquiries from abroad promise a continuance of active trade. Rumours are current that the steel makers are likely soon to advance prices 5s. per ton. In the meantime the quotations are, for angles, £6 10s.; ship plates, £6 15s.; bars, £7 10s.; and boiler plates, £7 12s. 6d., all subject to 5 per cent. discount for delivery in the Clyde district. While the steel works are generally kept well employed, the orders coming to hand for steel are reported only fair and not at all up to what might be expected. It is said that merchants, who are dissatisfied with the rebate arrangement, have been purchasing large quantities of material from outside sources, and that consumers are not taking full advantage of the offers made to them direct by the steel makers. It is not easy to ascertain to what extent these allegations are reliable, and the trade preserves a reticent attitude on the subject.

The Coal Trade.

Business has continued very active in the coal trade, both in the West and East of Scotland. There is in most of the colliery districts unwonted pressure for delivery. Merchants who are supplied under contracts of some standing complain that their deliveries are greatly behind. The excuse they invariably get from the collieries is that there is an inadequate supply of wagons for the current traffic. No doubt this is true, but merchants whose supplies are as much as several weeks in arrear are alleging that those who are paying the advanced current prices are being served before them. The temptation to do this is, of course, very great, especially as the highest rates are offered for prompt delivery. At several of the ports vessels have had to wait for loading, owing to the difficulty of getting the coals forward. Prices are firm. Steam coal is quoted, f.o.b. at Glasgow, 10s. 6d. to 11s.; ell, 11s. 6d. to 12s.; splint, 12s. to 12s. 6d.; washed treble nuts, 11s. 3d. to 11s. 6d.; doubles, 10s. 3d. to 10s. 6d.; and singles, 9s. to 9s. 6d. per ton. House coal is firmer, but has not advanced much to home consumers.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade, Cardiff.

Prospects indicate that with the closing of the year prospects will be brightened and the coal trade recover from one of the most disastrous blows yet received. An old authority, who can recall most of the early pioneers of the coal trade in Wales, is satisfied that the turn is at hand. The railway crisis was the last evil threatened, and there are now strong hopes that this will be arranged. Lessened storms last week allowed a larger incoming of steamers. The arrival, said one merchant, was so great that a little congestion arose at the dock, and many vessels had to await their turn to load. It was gratifying, however, to see that, under well-sustained energetic effort, the huge stocks began to lessen. Heavy bookings on Italian Government account at the close of the week began to droop, and the latest reports were that there was a tendency to credit the rumour that the agents of the Italian Government had been directed not to press for prompt supplies. This, however, was not believed to be correct. Another rumour on 'Change was that colliery owners were in many cases declining further business for December, and were even asking higher figures for January.

Present State of Trade.

Mid-week strong conditions were again in evidence in most branches of the steam coal trade. On 'Change it was said that most colliery owners were in an independent position for the remainder of the year, but inquiries were still numerous for all descriptions of large, and also for the bunker qualities of small.

Latest.

Tonnage arriving freely; pressure for prompt shipment is considerably in excess of the loading facilities, and daily vessels are waiting their turn to load. Quotations:—Best Admiralty large steam, 17s. 3d. to 17s. 6d.; best seconds, 16s. 6d. to 17s.; ordinaries, 15s. 6d. to 16s.; best drys, 16s. 3d. to 17s.; ordinary drys, 15s. 3d. to 15s. 9d.; best washed nuts, 14s. to 15s.; seconds, 13s. 6d. to 14s. 6d.; best washed peas, 12s. 6d. to 13s. 6d.; seconds, 11s. to 12s.; best bunker smalls, 8s. 9d. to 9s.; best ordinaries, 8s. to 8s. 6d.; cargo smalls, 6s. to 7s.; inferior smalls, 5s. 3d. to 6s. 9d.; best Monmouthshire black vein, 15s. 9d. to 16s. 3d.; ordinary Western, 15s. to 15s. 6d.; best Eastern, 14s. to 14s. 6d.; seconds, 13s. 3d. to 13s. 9d. Bituminous: Best households, 17s. to 18s.; best ordinaries, 15s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. to 17s. 6d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 9d. to 10s.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 9s. 9d. to 10s. 3d.; smalls, 6s. 3d. to 6s. 9d. Patent fuel, 16s. to 17s. Coke: Special foundry, 24s. to 25s.; foundry, 17s. 6d. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, ex ship, 29s. to 30s.

Newport (Mon.) Coals.

The total despatch of coal to foreign destinations last week reached 100,000 tons. The exact figures were 100,290 tons foreign and coastwise, 1747 tons coastwise. It was stated at the docks that despite the very heavy stocks standing over from the previous week, shippers had difficulty in keeping pace with the requirements; tonnage long delayed came in so strongly that the pressure was found greater than on any previous occasion, quite attesting to the estimate now formed of the coals. Latest:—Firm conditions prevailing; shippers very favourably placed both for prompt and forward delivery, harder values being sought for all the better qualities of large; smalls of the better class were active, but little change in others. House coals were strong; patent fuel firm; coke unchanged; pitwood coming in; better prices maintained. Latest prices:—Best black vein, 15s. 6d. to 16s.; Western Valleys, 14s. 9d. to 15s. 3d.; Eastern, 14s. to 14s. 3d.; other sorts, 13s. to 13s. 6d.; best smalls, 7s. 6d. to 8s.; seconds, 6s. 9d. to 7s. 3d.; inferiors, 6s. to 6s. 6d. Bituminous: Best households, 16s. to 17s.; seconds, 15s. to 15s. 6d. Patent fuel, 16s. to 16s. 6d. Coke: Foundry, 17s. to 20s.; furnace, 15s. to 15s. 6d. Pitwood, 28s. to 30s.

Swansea Coal Trade.

Greater activity than usual was displayed at Swansea last week, and the total of imports and exports was a few tons only short of the record made in the week ended November 17th, an increase of 34,000 tons compared with the corresponding week last year. Coal and patent fuel were very active, the combined shipments amounting to 117,000 tons. Latest:—Midweek the anthracite market continued to exhibit a very firm tone, which gives strong indications of lasting to the end of the year. Swansea large is firmly quoted at last figures. Owing to restricted outputs, due to labour troubles, sellers have difficulty in completing contracts. Red vein larger is better; machine-made nuts and cobbles a strong market. German nuts falling off; beans and peas firm; rubbly culm no change; duff improving; slight improvement in better qualities of steam. Latest:—Anthracte: Best malting, 21s. to 23s. net; seconds, 19s. 6d. to 20s. 6d. net; big vein, 18s. 6d. to 19s. 6d.; red vein, 12s. 6d. to 13s. 6d.; machine-made cobbles, 19s. 6d. to 22s. 6d. net; Paris nuts, 22s. 6d. to 25s. net; French nuts, 22s. 6d. to 25s. net; German nuts, 23s. 6d. to 25s. net; beans, 19s. 6d. to 22s. 6d. net; machine-made large peas, 11s. 9d. to 22s. 6d. net; rubbly culm, 5s. 3d. to 5s. 9d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal: Best large, 17s. to 18s. 3d.; seconds, 13s. 6d. to 14s. 3d.; bunkers, 10s. to 11s.; small, 6s. to 7s., all less 2½. Bituminous: No. 3 Rhondda, 17s. to 18s.; through, 13s. 9d. to 14s. 3d.; small, 10s. 3d. to 11s., all less 2½; patent fuel, 14s. 6d. to 15s. 3d., less 2½. Coal quotations all f.o.b. net cash 30 days.

Iron and Steel.

Dowlais has been tolerably busy of late, and last week the production of the mills was above the average. The Goat Mill was engaged on steel sleepers, tin bar, and an order for steel rails, while the Big Mill was occupied with a substantial tonnage of colliery material of light weight, such as angles, curves, and tramway rails with fish-plates. Latest market quotations:—Iron ore: Rubio, 20s. to 20s. 6d.; Welsh hematite mixed numbers, 63s. 1½d. cash, 63s. 4½d. month; Middlesbrough, 47s. 9½d. cash, 48s. 1d. month; Scotch, 53s. 9d. cash, 54s. month; Welsh hematite, 70s. delivered; East Coast hematite, 69s. c.i.f.; West Coast, same. Steel bars, Siemens, £5 to £5 7s. 6d.; Bessemer, £5. Other quotations:—Copper, £58 13s. 9d. cash, £58 8s. 9d. three months. Lead: English, £15 6s. 3d.; Spanish, £15 16s. 3d.; spelter, £26 17s. 6d. per ton; silver, $25\frac{3}{16}$d.

Tin-plate.

Shipments of tin-plates last week totalled 74,720 boxes, receipts from works 94,074 boxes, leaving stocks in the dock warehouses and vans 86,123 boxes. At Llanelly the tin market is showing some signs of weakness. Latest: Swansea reports that makers have further advanced their prices for tin-plate, and a fair business is being done, but the margin of profit is stated to be very small. American competition remains very severe. Latest quotations: Ordinary plates, 13s. 9d. to 13s. 10½d. per box; C.A. roofing sheets, £9 to £9 5s. per ton; big sheets, for galvanising, £9 to £9 5s.; finished black plates, £11 to £11 5s.; galvanised sheets, 24 g., £11 10s. per ton; block tin, f.o.b., cash, £194 5s. three months.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Sullivan Machinery Company, of Chicago, has recently opened a branch office at 814, Salisbury House, E.C., and Mr. H. T. Walsh is the London manager.

The Pullman Company, Limited, informs us that it has taken more commodious offices, and is removing into them on the 11th inst., when its address will be Victoria Station (South-Eastern and Chatham Railway), Pimlico, S.W. Telephone 84 Westminster.

The South Durham Steel and Iron Company, Limited, of Stockton-on-Tees, has appointed Mr. Geo. Marrs its sole agent for London and district for the sale of its manufactures. This necessitates Mr. Marrs severing his connection with Messrs. G. Bailey, Toms and Co., after a period of over thirty-five years.

We learn that Mr. Edwin Tonks, who has been connected for forty years with the large engineering and foundry works of Messrs. Taylor and Farley, Summit Foundry, West Bromwich, has notified his intention of retiring from the general management at the expiration of his agreed term early in the New Year. His brother, Mr. Charles W. Tonks, works manager, who has also been there for a long period, is retiring.

Mr. A. Hoffmann informs us that from to-day he is resigning his position as managing director of United Motor Industries, Limited, for the purpose of devoting himself entirely to the business of Ivel Agricultural Motors, Limited, of which company he has acted as manager for some nine years. After December 16th the head office of the company will be at the works at Biggleswade, Beds, where all communications should be sent.

Contracts.—The Worthington Pump Company, Limited, has recently received a number of orders for this country and for various other parts of the world. Among these we notice pumps and pumping engines, surface and jet condensers, air compressors, air and circulating pumps, cooling towers, vacuum pumps, feed pumps, fire pumps, and water meters.—The Underfeed Stoker Company has recently received orders for 99 stokers of different sizes, the orders coming from various parts of the world.

The widening works on the London and South-Western and Metropolitan District Railway between Ravenscourt Park Station and Chiswick Park Station were successfully completed on Sunday last, when the two additional lines were brought into use, thus securing for each company an independent set of tracks which will enable an even quicker train service to be run than hitherto. These works, which were started 15 months ago, have necessitated the widening of a viaduct 50 chains long and the construction of some 14 new bridges, several large retaining walls and extensive alterations to embankments, high-tension cables and stations.

Commercial Information Bureau at Capetown.—A Commercial Information Bureau is now attached to the office of the British Trade Commissioner, Norwich Union-buildings, St. George's-street, Capetown, for the purpose of supplying information, free of charge, to those interested in British trade. The object of the bureau is to assemble, under one roof, as much commercial information as possible, dealing with the trade of the United Kingdom and South Africa. A list generally descriptive of the class of information available has been prepared, and may be obtained on application. In respect of up-country inquiries, the bureau readily undertakes to furnish information by post. It is announced that if at any time information is required that does not appear to be on record, the Commission will be glad to take the necessary steps to obtain it, if possible, provided that such information is associated with British trade interests.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c

(From our own Correspondent.)

Rheinland-Westphalia.

ACCOUNTS regarding the business on the iron and steel market are favourable on the whole; in many instances the orders booked extend to April of next year, and the terms of delivery are six to eight weeks. Foreign orders come in freely, and there is altogether a strong feeling reported. At a meeting of the Plate Convention on the 25th of November the prolongation of the Convention till the end of 1912 was resolved upon. Prices for the first quarter of next year have already been raised M. 5 p.t.

List Quotations.

The following are the present list rates per ton free at works:—Raw spathose iron ore, M. 11.60; roasted ditto, M. 16.50; Nassau red iron ore, 50 p.c. contents, M. 14.50; spiegeleisen, 10 to 12 p.c. grade, M. 72; white forge pig, Rhenish-Westphalian brands, M. 72; iron for steel-making, M. 64 to M. 66; German Bessemer, M. 74.50; Luxemburg forge pig, free Luxemburg, M. 48; German foundry pig, No. 1, M. 70.50; No. 3, M. 67.50; German hematite, M. 74.50; good merchant bars, common quality, M. 104 to M. 107; iron bars, M. 130 to M. 133; basic hoops, M. 127 to M. 130; common basic plates, M. 127 to M. 129; sheets, M. 137.50 to M. 140; drawn iron or steel wire, M. 122.50.

Coal in Germany.

Both in Rheinland-Westphalia and in Silesia engine coal remains in active request, and increasing activity is reported from all the principal coal districts. Never before have wagons been so scarce as they are now, and this is a great disadvantage both to producers and purchasers. To South Germany a somewhat better trade has been done of late, owing to the Rhine having risen considerably during the last few weeks. With Holland also a fair business in coal is being transacted. For house fuel a very lively demand continues to come in, and in coke a steady and increasing business is reported. Stocks in gas coal are still extensive. Briquettes meet with strong demand, Belgium and Holland being very good customers.

Austria-Hungary.

Considering the time of the year, demand and employment are fairly good in the iron and steel industry. Bars and girders are especially well inquired for, while heavy plates are a trifle less active. Sheets sell briskly, and so do pipes. Symptoms of improvement can be noticed in the locomotive and wagon-building department, the Government having at last been induced to promise orders in wagons, locomotives, and general railway rolling stock. The coal trade in Austria and in Bohemia has been tolerably active during this week and the last, but it cannot be fully developed until a sufficient number of wagons is available.

Healthy Tone in France.

Business transactions have been regular and increasing during the week past, both dealers and consumers purchasing freely; confidence, generally, increasing. Some large orders for private and Government railways have given additional strength to the iron market. No less than 4850 wagons have been ordered from a number of French and Franco-Belgian shops; to these must be added 1000 covered wagons for the Orleans Railway, 100 passenger cars and wagons for the East Railway, and 255 passenger cars and tenders for the State Railway. The steadily increasing demand for plates has led to a further advance in prices, and Paris quotations for 3 mm. sorts are 220f. to 240f. p.t., as compared with 210f. to 225f. in the beginning of the month. In the Meurthe-et-Moselle department 200f. p.t. has been taken, whereas in the Haute-Marne up to 240f. p.t. is being asked. Sheets are firm in price and well inquired for; bars also show much stiffness. Iron bars are quoted 155f. p.t. in the Nord—even 160f. p.t. has been quoted—while basic bars are sold at 150f. to 165f. p.t., according to quality. In the Meurthe-et-Moselle department, 157f. to 162f. p.t. are quoted for iron bars, and 162.50f. to 167.50f. p.t. for steel bars. On the Paris market 170f. p.t. is, on an average, quoted for iron bars, while 170f. to 175f., and even 180f. p.t., is quoted for basic bars. Drawn wire and hardware are in good condition; bolts and rivets were last week raised 2f. per 100 kilos. The iron manufacturers will be able to transact a more profitable business next year, because the Comptoir de Longwy has reduced the prices for crude iron by 1f. p.t. for 1912; basis quotation for foundry pig No. 3 will be 77f. p.t. The heavily reduced rates for coke, caused by an agreement between the blast furnace companies and the cokeries, may be considered a principal cause for the above-mentioned reduction in pig iron prices.

Iron and Steel in Belgium.

A further upward tendency is reported from the iron and steel market, numerous and extensive contracts coming in. Prices generally are stiffening. Bars for export have advanced 2s. to 4s. p.t., while plates show a rise of 4s. p.t. on an average. At present bars stand at £4 19s. to £5 p.t. f.o.b. Antwerp, and there is good reason to expect the present maximum quotations to become the ruling prices shortly both for iron and steel bars. Rods have advanced to £5 p.t. Heavy plates continue in regular demand, and £6 to £7 1s. p.t. have been quoted. In rails a steady business is being done; 20,000 t. have been ordered on behalf of Japan and Brazil. Girders are briskly called for in spite of the advanced season. Crude iron is slowly showing more strength. During the first ten months of this year the output rose to 1,737,400 t., as compared with 1,482,740 t. during the same period last year. There are 43 blast furnaces at work now out of 50 existing.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 29th.

WITHIN a brief period the trunk lines have ordered 340,000 tons of steel rails for next year's delivery. The pending orders of the Pennsylvania and the New York Central will be more than last year's orders, and will exceed 300,000 tons. The car builders are enjoying a rush of business, and so far this month the orders foot up 37,700 cars, as against 20,400 cars ordered between July 1st and November 1st. The railroads need much new rolling stock, and on some lines much of the stock is ready for the scrap heap. Several structural and plate mills are running to full capacity, as against about 65 per cent. of capacity during the summer months. The estimated requirements of the Pennsylvania road for cars is placed between 15,000 and 20,000. The Grand Trunk and the Canadian Pacific has placed orders for 4500 cars. The Chicago and North-Western will probably place an order this week for 3500 cars, and several southern roads are figuring on orders which will aggregate several thousand more. It is given out on apparently sound authority that the Harriman lines will place orders for an aggregate of 25,000 cars. Gas plants in Philadelphia and Detroit have brought out orders for 16,000 tons of plates and shapes. Two awards are to be made in this city very soon—one for 12,000 tons for the merchants' and manufacturers' building, and 3000 tons for a loft building. The low prices prevailing are largely but not altogether responsible for the extraordinary activity. During the past week copper bounded upwards 40 points, and is quoted to-day 13¾ for electrolytic.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

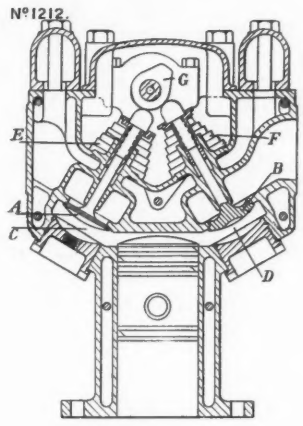
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of the Patent.

INTERNAL COMBUSTION ENGINES.

1212. January 17th, 1911.—IMPROVEMENTS IN THE VALVE MECHANISM OF INTERNAL COMBUSTION ENGINES, the Calthorpe Motor Company, Limited, Cherrywood-road, Bordesley Green, Birmingham; T. C. Copson, Rokeby, Northumberland-road, Coventry; and J. P. Hillhouse, Highland Cottage, Malvern Wells.

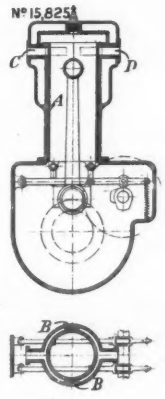
In this invention the inlet and exhaust valves are operated from the same cam. The inlet valve A and exhaust valve B open into



pockets C D respectively formed on the sides of the cylinder head. These pockets are closed by screwed caps, one of which may carry the sparking plug. The poppet valve spindles are inclined towards one another, and are controlled by the springs E, F. A cam shaft carrying the cam G lies centrally over the cylinder head and operates the valves A and B and those of other cylinders, each cylinder being provided with a separate cam.—*November 15th*, 1911.

15,825. July 7th, 1911.—IMPROVEMENTS IN VALVES FOR INTERNAL COMBUSTION ENGINES, Louis Renault, 15, rue Gustave, Sandoz, Billancourt, Seine, France.

In the engraving the gudgeon pin and connecting-rod are shown, but the piston is omitted. Between the piston and the wall of the cylinder a sleeve A, split longitudinally into two parts, is interposed. The upper edge of this sleeve is turned over and forms a valve face, the seat for which is provided on the cylinder itself. The longitudinal joints are covered by strips B B formed on the

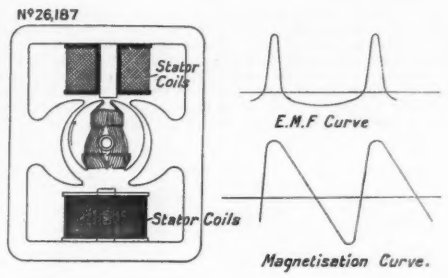


cylinder. C is the inlet and D the outlet port. The two parts of the sleeve A form, of course, the inlet and outlet valves. The manner of driving each half is obvious from the engraving. The arrangement secures large port openings with only a small movement of the valve parts. Two modifications are also described. In one the sleeve is not split and serves only as an exhaust valve, the inlet valve being of the usual poppet form. In the other the sleeve is likewise solid, and serves both as an inlet and exhaust valve. This is secured by providing two ports which are opened and closed alternately by shutter valves.—*November 15th*, 1911.

DYNAMOS AND MOTORS.

26,187. November 26th, 1910.—IMPROVEMENTS IN ELECTRIC GENERATORS, *Dr. Max Breslauer, of Berlin-Hoppegarten.*

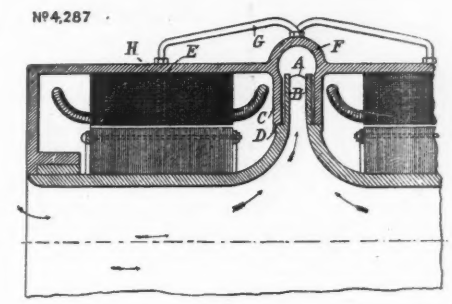
This invention relates to an electric current generator designed to generate an alternating current the two alternations of which are unequal, comprising in combination with induction coils a rotatable magnet; two pole tips of opposite polarity are very near to one another, and have a small air gap between the stator and rotor, whereas the opposite pair of tips are more remote from one another, and have a greater air gap between the stator and rotor, the air gap being tapered gradually from the small width to the larger width, so as to secure a gradual decrease and an equally gradual increase of the magnetism in the induction coil up to the maximum, whereas the change from one maximum to the other is as rapid as possible. The magnetic resistance of the circuit, including the iron cores of the induction coils, is practically the resistance of the gap between the cores and the magnet, the other part of the magnetic circuit having a comparatively small resistance, which is practically constant during the full period. The object of this invention is to generate high-tension currents approximating to direct currents under conditions more closely



approximating to those of ordinary dynamo practice.—*November 15th*, 1911.

4287. February 20th, 1911.—IMPROVEMENTS IN AND RELATING TO ELECTRIC MOTORS FOR PUMPS, William Richard Macdonald, of 60, Hallam-street, Portland-place, London, W.

This invention relates to a combined electric motor and pump, especially designed for working under water, though also applicable generally. The field or stationary portion of the machine is divided, and the pump blades are secured to or formed upon the centre of the rotor or its shaft. A portion of the water propelled by the motor may be admitted through wire gauze or the like to the motor windings for cooling purposes. The armature core is secured upon a hollow shaft of large diameter, the central part of which forms the inlet for water passing to the pump. The

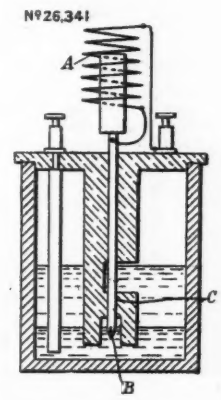


shaft has formed upon it at its centre curved blades A, forming a centrifugal pump. Preferably these blades are formed between discs, and the pump is further enclosed by the partition walls C making joint with shoulders D upon the rotating portion. This arrangement prevents passage of water from the pump laterally outwards to the motor. The casing of the motor, to which is secured the stator or field core E, surrounds the pump as well as the motor windings. It is expanded at F around the circumference of the pump blades to form an outlet passage. A by-pass G may be provided from this passage leading through channel H to the air spaces of the motor. This will permit water to flow into the motor for cooling purposes, but the passage must be guarded by gauze or the like to prevent solid matter following the same path. Another construction is also described.—*November 15th*, 1911.

SWITCH GEAR.

26,341. November 12th, 1910.—IMPROVEMENTS IN AND RELATING TO MERCURY CONTACT BREAKERS, *The Reiniger Gebbert and Schall Aktien-Gesellschaft, of 27, Luitpoldstrasse, Erlangen, Bavaria, Germany.*

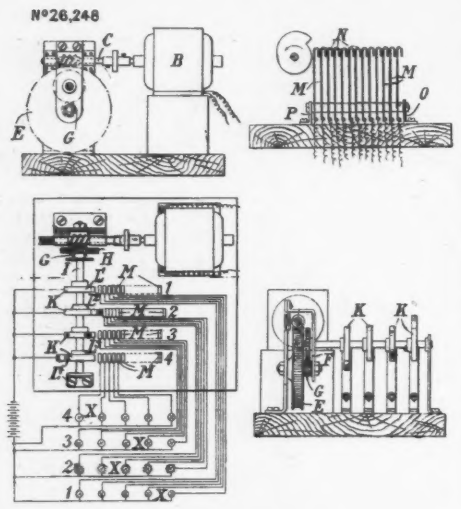
This invention relates to a mercury contact breaker, and has for its object to utilise the heating effect of the spark which is produced when the contact is broken to effect a rapid separation between the contact point and the surface of the mercury, and thus a rapid extinction of the spark. For this purpose a gas or steam blast is formed at the end of the contact pin when it leaves the mercury by the action of the spark on an extinguishing fluid floating on the surface of the mercury. The contact is enclosed by a bell or chamber, which is closed at the bottom by the mercury, and prevents the gas or vapour which is generated by the action of



the spark on the extinguishing fluid from expanding upwards, so that the pressure of the gas and vapour is caused to act downwards on the surface of the mercury situated at the point of interruption, and the mercury is suddenly forced downwards by the generated gas or vapour, whereby the spark produced on the breaking of the contact is rapidly extinguished, and thus a complete interruption of the circuit ensured even when the contact pin is raised relatively slowly. The contact pin can be moved by a solenoid A furnished with the contact pin B. It should be understood that the chamber C is closed at the top. When the contact pin is raised through the action of the solenoid to such an extent that it quite leaves the mercury the heat of the spark formed at the point of interruption acts on the extinguishing liquid, alcohol for example, generating enough gas to produce a relatively high pressure.—*November 15th*, 1911.

26,248. November 11th, 1910.—IMPROVEMENTS IN ELECTRIC CURRENT CONTROLLING DEVICES OR SWITCHES, William Kennedy-Laurie Dickson, of 4, Denman-street, Piccadilly Circus, London, W.

This invention relates to an improved electrical device or multi-switch for connecting the current to a number of electric lamps, and is particularly suitable for use with signs in which the lamps are illuminated one after the other to produce a "writing" effect. B is the electric motor, the spindle C of which carries a worm D adapted to drive the wheel E supported by the frame F having rigid with it a small toothed wheel G meshing with a larger wheel H on the spindle I, upon which four cams K set in echelon are

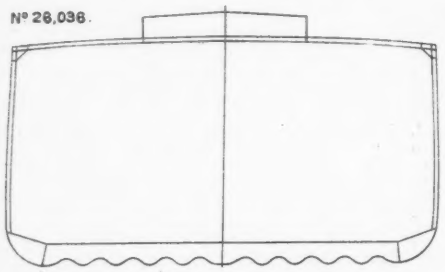


fixed. The noses or projecting parts of these cams are respectively lettered I^1, I^2, I^3, I^4, and are adapted to press against the spring contact blades M, the upper or contact ends of which are rounded, whilst towards the lower ends the blades are mounted on the insulated bar O supported by brackets P. Each of these blades is connected to its lamp or lamps X, and it will be seen that the series 1 is connected to the lamps 1, the series 2 to the lamps 2, and so on, and it will be observed that the cam K—I^2 is pressing together the blades 2, and thereby illuminates the lamps 2. Any suitable means may be employed for the purpose of switching on and off lamps of different colours, and thereby producing multi-colour effects.—*November 15th*, 1911.

SHIPS AND BOATS.

26,036. November 9th, 1910.—IMPROVEMENTS IN THE CONSTRUCTION OF SHIPS AND DESIGN, A. E. Beresford, 46, Marshfield-avenue, Goole, Yorkshire.

It is proposed to form the bottom of the ship in the corrugated manner shown in the drawing. These corrugations run parallel and full width from end to end of the hull, and may have a pitch of about 3ft. and a depth of about 8in. Among the numerous

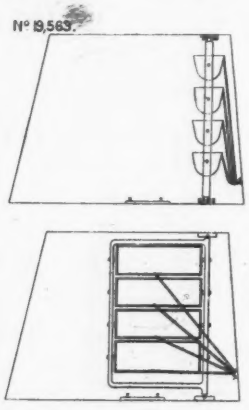


advantages claimed for this construction we note the following:—The longitudinal and transverse strengths are increased; hence the number and size of the fore and aft girders can be reduced and side stringers may be discarded. Rolling is retarded and vibration lessened. The "grip" of the corrugations on the water facilitates the steering of a straight course.—*November 15th*, 1911.

MINES AND METALS.

19,563. September 2nd, 1911.—FIRE EXTINGUISHING DEVICE FOR LOCALISING COAL DUST EXPOSIONS, Hermann Kruskopf, 75, Altestrasse, Dortmund, Cörne, Germany.

A frame carrying a number of water troughs is hinged vertically



in the gallery, and normally lies flat against the side. The troughs are each provided with a rope, hitched to a staple in the wall of the gallery. The force of the air blast preceding the flame of the coal dust explosion blows the flame out across the gallery, thereby tightening the ropes and upsetting the troughs. The water is thus carried by the air blast along the gallery, and this, as shown at the Liévin experimental gallery, stops the propagation of the explosion. To prevent the flame from leaping over the top trough, a secondary water trough is mounted on trestles high up against the roof of the gallery in advance of the frame illustrated. The force of the air blast upsets the trestles, and so distributes the water in the upper regions of the gallery.—*November 15th*, 1911.

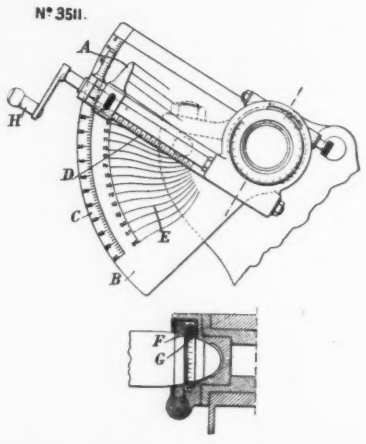
26,869. November 18th, 1910.—IMPROVEMENTS IN THE TREATMENT OF BLAST AIR, Leo Franck, Differdingen, Luxemburg.

It is proposed to enrich the air entering a blast furnace by passing it over barium dioxide, which, at temperatures between 600 and 900 deg. Cent., gives off oxygen. The air is first dried and freed from carbon dioxide and then heated to the required temperature in a Cowper stove. After the supply of barium dioxide is used up in the enriching process it is subjected to the action of an air blast at a temperature of 350 to 500 deg. Cent. This regenerates the substance, converting the monoxide into the dioxide.—*November 15th*, 1911.

ORDNANCE AND ARMOUR.

3511. February 11th, 1911.—APPARATUS FOR AUTOMATICALLY INDICATING THE TIME OF FLIGHT OF A PROJECTILE AND THE FUSE THEREFOR, *A. G. Bloxam, Birkbeck Bank Chambers, Southampton-buildings, London.*

The time of flight of a projectile varies for the same range with the altitude of the target. Hence the time setting of the fuse in the projectile depends both on the range and the altitude. The time of flight in this invention is automatically indicated by a pointer A attached to and turning with the trunnions, and moving



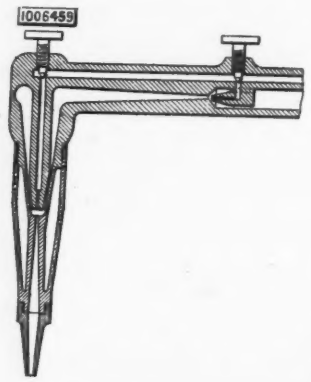
over the face of a sector plate B fixed to the gun-carriage. The sector plate is engraved at C to show degrees. The pointer A moves along an arm D marked to show the range. The lines E indicate the time of flight. The invention is shown combined with a machine for setting the fuse of the shell. This machine consists, as usual, of two setting noses F and G, and is situated within the mouth of the hollow trunnion. The setting noses are rotated by means of the handle H. The operator responsible for the setting of the fuse has thus constantly before his eyes an indication of the time of flight of the shell.—*November 15th*, 1911.

SELECTED AMERICAN PATENTS.

(From the United States Patent-office Official Gazette.)

1,006,459. APPARATUS FOR AUTOGENOUS METAL WORKING, *W. Brandes, Gottenborg, Sweden.—Filed November 18th*, 1909.

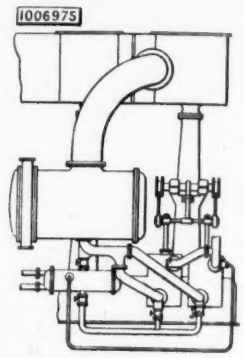
This patent is for a blow-pipe, with a body portion having an oxygen gas duct therein, a combustible gas duct substantially parallel with it, having a branch extending toward the combustible gas duct, a nozzle on said branch communicating with said combustible gas



duct, and a mixing chamber centrally aligned with the combustible gas duct and communicating with the latter, this mixing chamber comprising an annular portion having an extension terminating in an annular nozzle, the oxygen gas duct having a branch at one end extending through the annular portion and communicating with a relatively small oxygen gas nozzle. There are seven claims.

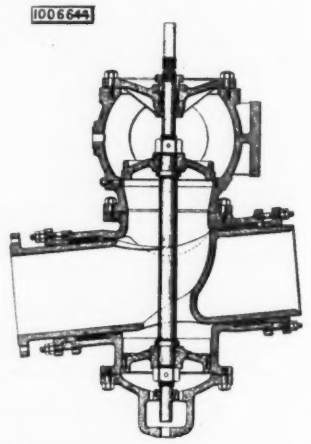
1,006,975. STEAM CONDENSING PLANT WORKING UNDER VACUUM, *D. B. Morison, Hartlepool, England.—Filed February 23rd*, 1910.

This patent is for steam condensing plant comprising a surface condenser, a pump capable of withdrawing air, vapour and water arranged normally to withdraw air and vapour from said condenser, a second pump also capable of withdrawing air vapour and water, arranged normally to withdraw water of condensation from the condenser, the pumps being connected together on their suction sides, a water cooler wherein water of condensation is cooled to a temperature below the temperature of the water in the condenser, means whereby water can be admitted from this water cooler to the first-mentioned pump and means whereby cooled water can also be



admitted to the second pump when desired. There are twenty-four claims.

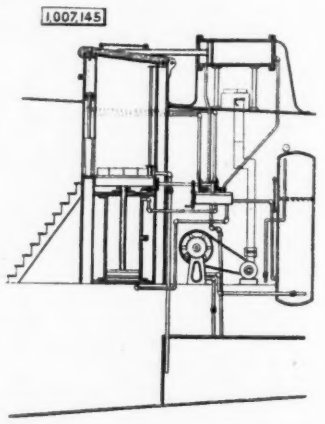
1,006,644. THROTTLE VALVE AND SLIP JOINT, *J. H. Freeman, Weymouth Heights, Mass., assignor to General Electric Company, a Corporation of New York.—Filed September 15th*, 1909.



The combination with a throttle valve of a steam main extending transversely through the casing of the valve and longitudinally movable in it. There are eleven claims.

1,007,145. ESCAPE DEVICE FOR SUBMARINE BOATS, *J. Schuitter, Baltimore, Md.—Filed September 6th*, 1910.

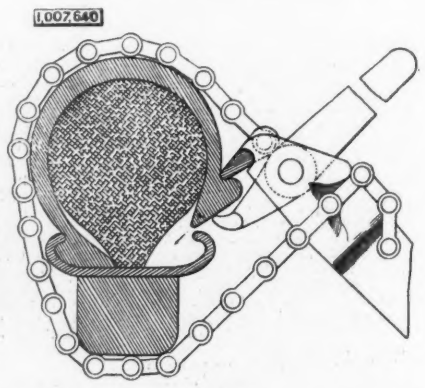
The escaping crew ascend the stairs, and, entering a vertical



cylinder, stand on the piston, which is raised by compressed air, and so lifts them to the outside of the boat through a water-tight trap door, worked as shown. There are ten claims.

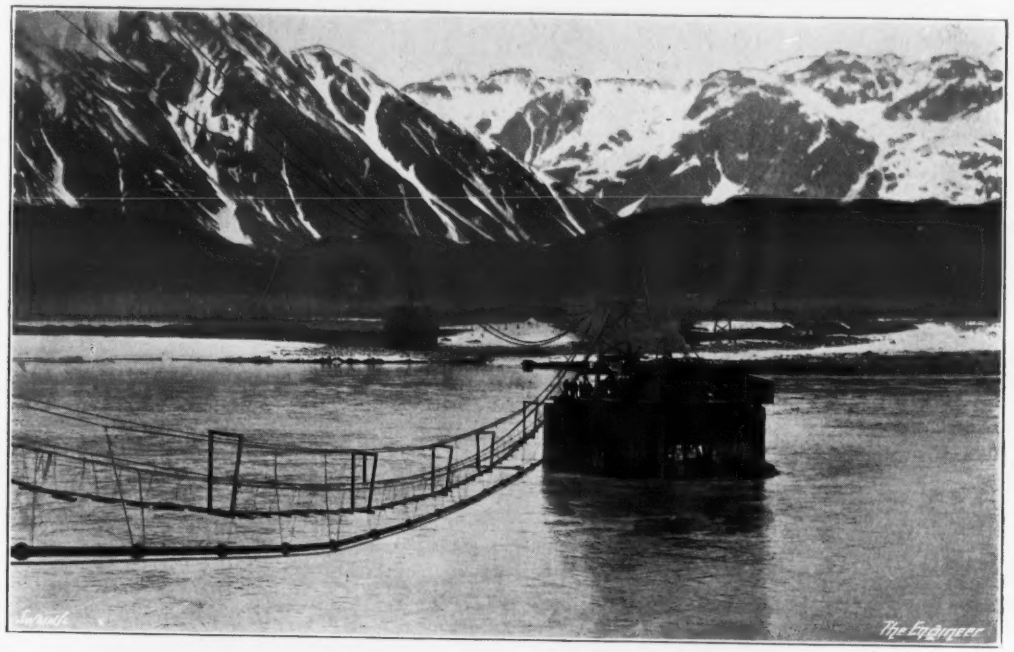
1,007,640. TIRE TOOL, *J. L. Butler, Akron, Ohio, assignor to the American Tire and Rubber Company, Akron, Ohio, a Corporation.—Filed April 3rd*, 1911.

This patent is for a tool for compressing and attaching wheel tires, comprising a main lever and an auxiliary lever pivoted

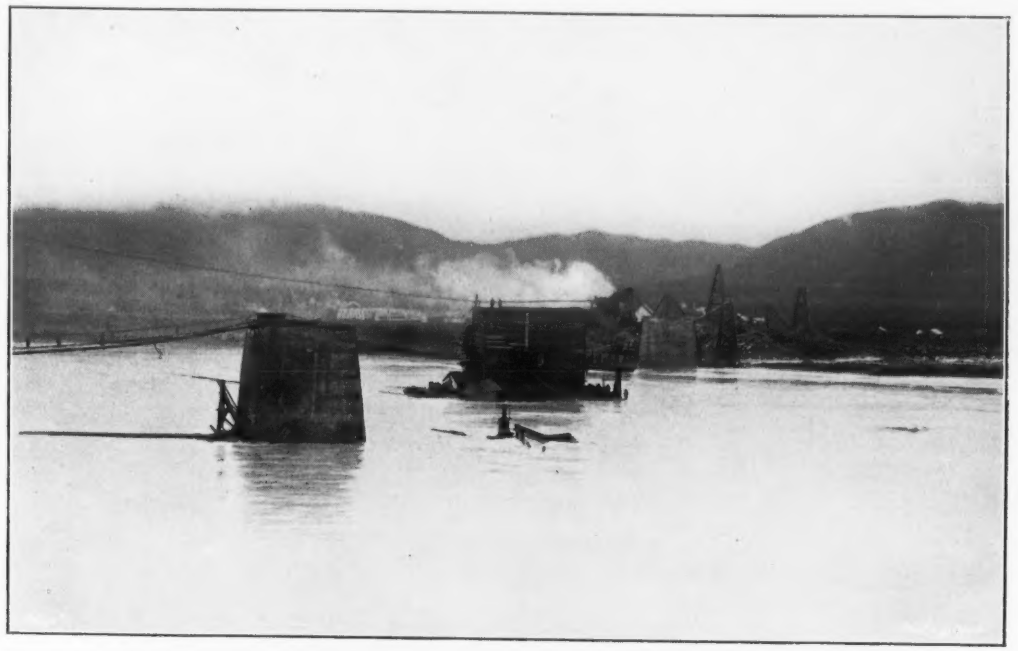


thereon and having a guiding jaw, and chains adapted to be drawn about the tire and operatively engaged at their ends with the main lever. There are six claims.

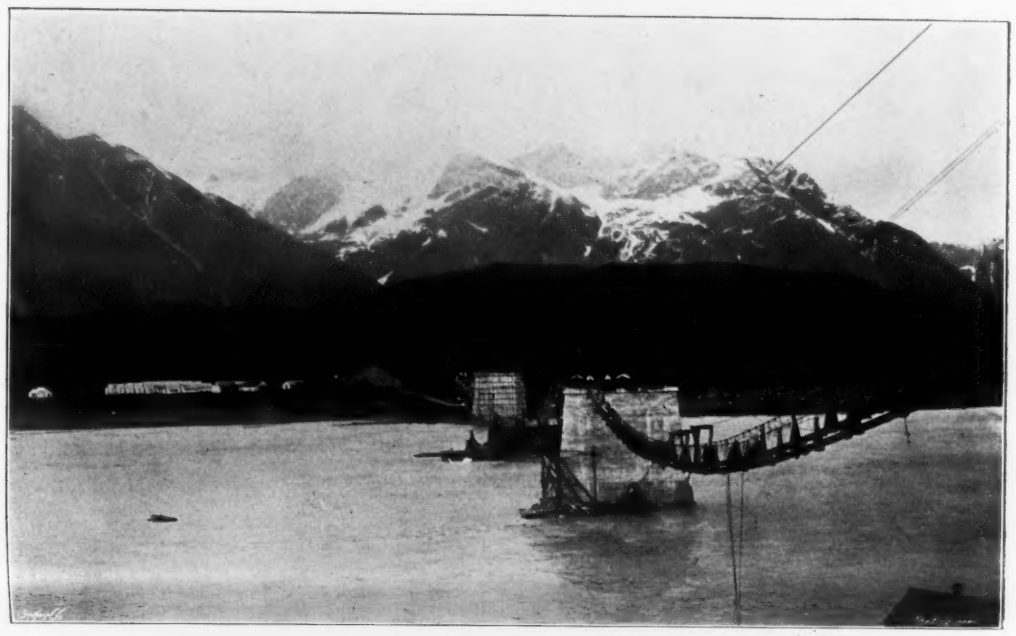
THE MILES GLACIER BRIDGE OVER THE COPPER RIVER, ALASKA



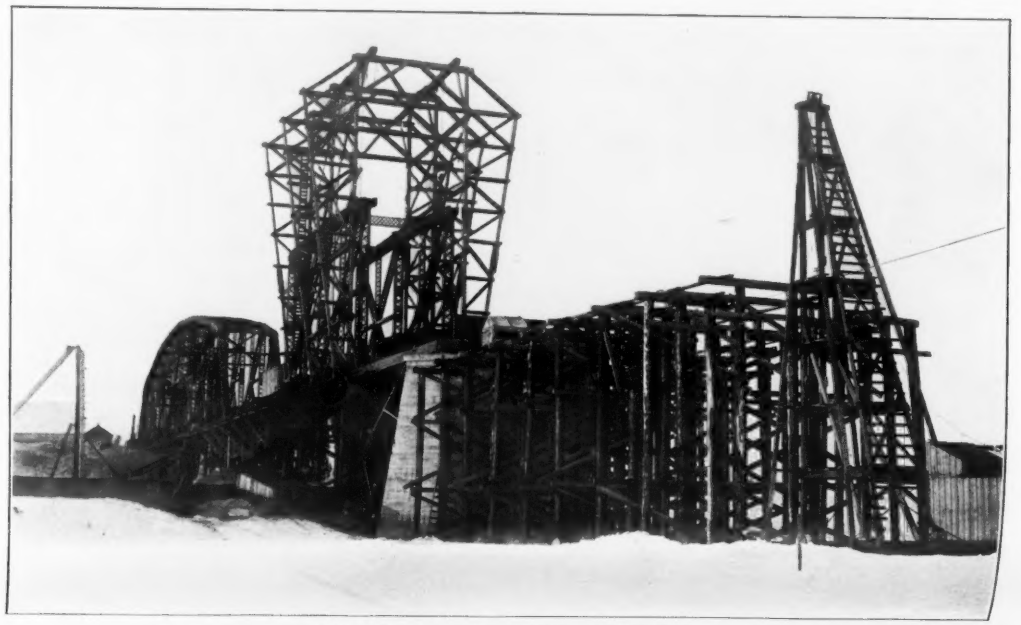
SINKING A CAISSON, JUNE 2nd, 1909



CAISSON AND TWO FINISHED PIERS, OCTOBER 15th, 1909



CABLEWAYS AND FOOTBRIDGE

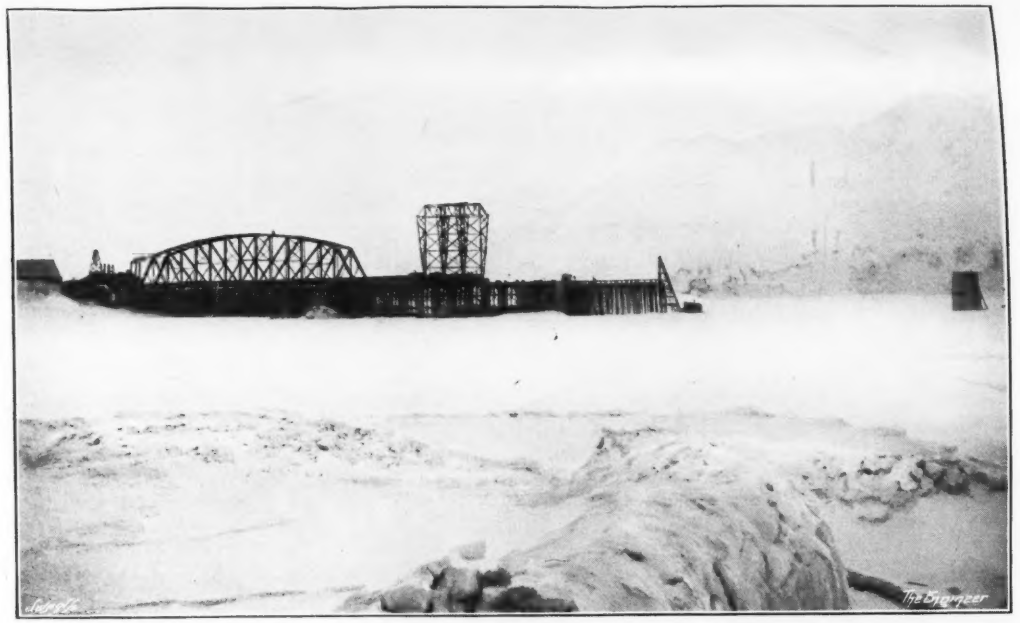


VIEW OF STAGING AND ERECTING GANTRY

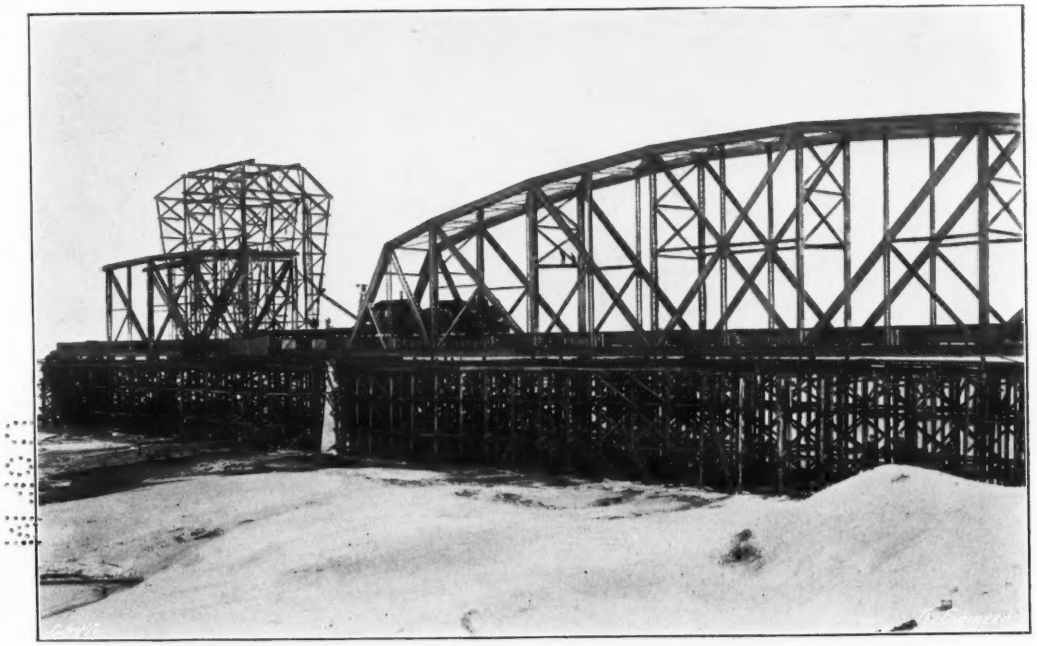
CABLEWAYS AND FOOTBRIDGE

VIEW OF STAGING AND ERECTING GANTRY

FIRST SPAN OF THE BRIDGE COMPLETED, APRIL 18th, 1910



SHORE SPAN COMPLETED, APRIL 19th, 1910



ERECTING THE SECOND SPAN, MAY 9th, 1910

THE COMPLETED BRIDGE

REPORT ON LONDON TRAFFIC.

As briefly noted last week the fourth annual report of the London Traffic Branch of the Board of Trade has now been issued. The Branch, as is well known, carries on the work of the Royal Commission on London Traffic, which concluded its sittings in 1905. The present report covers the year 1910 and part of the current year.

The last report—a summary of which appeared in our issue of February 17th, 1911—dealt, it will be remembered, with certain definite proposals for the relief of the congestion of traffic in the London area. As a result of a traffic census, carried out at various representative centres, an elaborate scheme for the construction of certain new arterial and cross-communication roads, and for the improvement of several inadequate existing thoroughfares, was suggested. Altogether the scheme comprised the construction of nearly 100 miles of new road and the improvement of over 25 miles of existing road. The width of the proposed roads was to vary from 100ft. for the main roads to 25ft. for second-class district roads. The present report, while on the whole preserving the former scheme unchanged, has altered it in one or two details, and added a fresh arterial road to the suggestions. The most important of the alterations is the removal of the proposed North Circular Road some two miles further north. The new artery proposed, known as the New Cambridge Road, is to leave the Enfield Road a little north of Stoke Newington, and, running north, is to join the existing Cambridge Road near Cheshunt. This road, with its cross-connections, would mean 11.2 miles of new work and 0.6 mile of improvement. Altogether the total length of new roads now proposed is over 122 miles, and of improved roads over 27 miles, as compared with the 100 miles and 25 miles respectively of the previous report.

While the third report dealt solely with the outlying districts, as being the more urgently in need of improved roads, the present report includes some reference to the requirements of the central district. Facilities for transit from east to west and from north to south are considered, and, as a result of careful investigation, the construction of 2.15 miles of new road, and the improvement of 6.75 miles of existing road, are recommended. The most important new road proposed is one of a mile in length running from the City-road to Goodge-street. Such a road would, it is believed, relieve the congestion of traffic in Oxford-street, Theobald's-road, Clerkenwell-road, and Old-street. Three quarters of a mile of existing road would, in addition, have to be improved under this scheme. The most important of the improvements suggested are 1.9 miles in Kentish Town-road, 1.8 miles from Caledonian-road to Mount Pleasant, and 1.3 miles between Seymour-street and Southampton-row. The extension of the Victoria and Albert Docks contemplated by the Port of London Authority is being kept in view, and the necessity for better means of communication by road in this district is noted. A new or improved road is foreshadowed which would incidentally relieve Canning Town Bridge and the East India Dock-road.

Under the heading "Bridges and Tunnels" the report summarises the authorised and projected work which has come into prominence since the previous issue was drawn up. The Woolwich tunnel is making good progress, the projected St. Paul's Bridge, after much criticism, has been approved; the reconstruction of Southwark Bridge and the widening of Kingston Bridge have also received the Royal Assent, and in 1912 authority will be sought for the reconstruction of Lambeth Bridge. Beyond thus merely recording the above facts in detail the report makes no suggestion of its own for the improvement of cross-river communication.

The report similarly records the progress being made with street improvements, tramway and railway extensions, and other matters having a bearing on the problem of London's traffic. In the section on tramways the report gives some interesting details connected with the working of the Bradford and Leeds railless systems. In Bradford 1¼ miles and in Leeds 4½ miles of route are now worked in this manner. Carrying twenty-eight passengers and luggage, the cars in both cities can attain a speed of 10 miles an hour, the two motors used on each car having a total output of 40 horse-power. A deviation of 15ft. from either side of the centre is permitted by the system. At Bradford, it would appear, the consumption of current is about 0.95 of a unit per car mile, or about half that required by an electric car. (It is to be noticed that the average electric car carries about twice the number of passengers.) At Leeds the consumption is 0.87 of a unit per car mile. The cars cost £700 apiece. The receipts per car mile are 8.78d. at Leeds and about 6¼d. at Bradford. The operating costs in both cases are estimated at 5¼d. per car mile. Fifteen Bills were deposited in 1911 seeking power from Parliament to install the railless system. Two of these Bills related to the London area. The report states that the system appears to be most applicable in places where a profitable outlet for surplus electrical energy is sought, and where traffic is likely to develop to an extent which will justify the ultimate construction of a tramway. In other conditions, adds the report, it is doubtful whether the system offers any advantages over a service of self-propelled vehicles.

As we have already stated, a proposal is under consideration by the General Post-office for the construction of an underground electric railway for the transmission of mails. The Departmental Committee appointed by the Postmaster-General to inquire into this subject reported in February of this year that on the score both of efficiency and cheapness, an electric railway would be preferable to any system of pneumatic tubes. In Chicago an electric railway, 60 miles in length, is already at work transmitting the mails under the main streets of the city. A similar railway is under consideration in Berlin, and an experimental track has been constructed. In Vienna an electric railway, about 40 miles in length, for the same purpose is likewise being discussed. The railway proposed by the London Committee is a tube 7ft. 6in. in diameter laid in the London clay, and containing a double track of 2ft. gauge rails. Each wagon would be provided with a motor capable of propelling it at a maximum speed of 35 miles an hour. The railway would traverse the centre of London from East to West, and would have a total length of 6½ miles. Starting at the Eastern District Office in Whitechapel-road, the railway would take in Liverpool-street Station, the General Post-office, Mount Pleasant, the Western Central District Office in New Oxford-street, and the Western District Office in Wimpole-street, and would terminate at Paddington Station. The estimated cost of construction is about £513,000. Numerous extensions of the system are contemplated, the result aimed at being the connecting up of all the principal district offices with each other and with all the principal railway termini in London. There are at present nearly 1000 mail vehicles of all kinds in use throughout the London Postal Service area. The underground scheme realised in its entirety, would thus suppress 5000 to 6000 daily services, and would therefore go far to relieve the congestion of traffic in the neighbourhood of the principal post-offices.

BRITISH TRADE IN HUNGARY: OPENINGS FOR MANUFACTURERS OF MACHINERY.

(From our Special Correspondent.)

BUDAPESTH, November 16th.

IT is a matter of no little disappointment to find in the Mid European countries the same record of a gradually dwindling British trade such that has been observed and commented upon in these columns with regard to the Latin-American States. In Austria-Hungary close inquiry leads to the conclusion that the volume of British trade, while still of considerable dimensions, has fallen off to an appreciable extent during the last few years, mainly owing to keen competition on the part of Germany, and, in a lesser degree, to the rivalry of the United States, and also partly to bad trade generally.

In Hungary this feature is particularly noticeable, more especially perhaps with regard to the agricultural machinery, implements, and general iron and steel trade. It would appear that some twenty or thirty years ago many leading British manufacturers of agricultural machinery and implements were either directly represented in Hungary or had their travellers calling regularly upon the principal importing houses. To-day that large number has been reduced to one firm, and at the time of writing it seems that this one solitary house is about to disappear and to become absorbed in two of the existing native competing establishments.

Several years ago Clayton and Shuttleworth, Limited, were enterprising enough to establish a factory in Budapesth, and, later on, in Bulgarian and Roumanian cities. So well did they organise their undertaking that this Budapesth branch proved one of the most prosperous features of their enterprise. It may be observed that the customs rates which are levied upon foreign machinery are almost of a prohibitive nature; and it was with a view to overcoming these serious obstacles to trade that Clayton and Shuttleworth, Limited, proceeded to erect their own factory. As stated, this idea when carried out proved eminently successful, the work of the firm being known and esteemed throughout the Hungarian kingdom as well as in most cities and towns of the Empire of Austria.

Last month (October), however, the debenture holders of the company were informed by the directors that, after mature consideration, they had decided, if the scheme were finally approved of by the shareholders, to dispose of their undertakings in Austria-Hungary, Roumania, and Bulgaria, upon terms which would enable the company to pay off the whole of the debenture stockholders. In the circular referred to, there was no mention of the total amount of the debentures concerned; but I may say that the stocks of this outstanding class of securities amounts to £250,000 First 4 per cent. debentures and £400,000 "B" 4½ per cent. debentures, or a total of £650,000. According to the terms upon which these debentures were originally issued, the 4 per cent. Stock was to be redeemed at 110 per cent. and the "B" 4½ per cent. stock at 105 per cent., so that it will not be difficult to arrive at the total amount which has been offered by local capitalists for the purchase of this branch of the Clayton and Shuttleworth Company's business. While the debenture holders presumably may be congratulated upon receiving so satisfactory a figure for their business—the bonds quite recently stood at but 95 per cent.—British trade generally will have sustained yet another blow in Mid-Europe, a blow which comes, moreover, at a particularly unfortunate moment, when competition of every kind is at its keenest.

The only other British firm which is in any way directly represented in the agricultural machinery line is that of J. Fowler and Co., Limited, of Leeds, whose ploughs, both steam and horse, may be met with occasionally, and whose selling agents in these countries have hitherto been Clayton and Shuttleworth, Limited. The only other foreign agricultural machinery which is dealt in to any extent is that received from the United States, and which is, as a rule, of the cheap and gaudy class, with very poor wearing qualities but evidently made "to sell."

It should be remembered that Hungary is essentially an agricultural country, the agricultural proportion of the community, indeed, amounting to little less than 70 per cent. of the entire population. Under ordinary circumstances, therefore, there should be found an admirable field for manufacturers of most classes of agricultural machinery and implements. British traders are eminently popular here as in other parts of the world, with the exception, perhaps, of Austria; and even the ignorant Hungarian peasant class would sooner do business with British representatives than with others, and least of all would they trade with Austria, the very name of which country is anathema to the patriotic Hungarian. Nevertheless, out of a total import trade shown by Hungary for 1910, and amounting to £74,014,009, Austria claimed about 72.47 per cent., while Germany secured 7.88 per cent. The United Kingdom figures only for 1.71 per cent., but British India should be added to this total with 1.89 per cent. as its contribution; both figures are superior to those of the United States, which can claim no more than 1.47 per cent.

While, as I have indicated, the agricultural machinery and implement market is now practically closed to British manufacturers, on account of the heavy duties imposed and the considerable number of subsidised local factories which have been established, there are still some few opportunities open for the extension of British trade with this country. While Hungary may be regarded as essentially a wheat-growing country, the vagaries of the climate, combined with other local circumstances, frequently occasion a bad harvest, such, for instance, as that experienced in 1909, when the amount of cereals grown and reaped fell so lamentably short of native requirements that foreign corn had to be imported to the value of £10,000,000. Both last year and this year, however, much better times have been experienced, and normal conditions have again been restored. How varied have been the harvests during the past five years can be seen from the following statistics, for which, I may say, I am indebted to the courtesy of the British Consul-General Mr. E. Grant Duff, of whose energies and capabilities it would be difficult to speak too highly. Unlike so many British Consular officials, Mr. Evelyn Grant Duff exhibits a keen and intelligent interest in his work, and in spite of the meagre materials which are at his disposal he manages to secure and to publish some really valuable statistical information for the benefit of our commercial community at home.

The harvest particulars, to which I have referred, for the last five years, calculated in metric centners, are as follows:—

	1906.	1907.	1908.	1909.	1910.
Wheat ...	53.7 ..	32.2 ...	42.8 ...	30.85 ...	50 29
Rye	13 74 ...	14 25 ...	10.5 ...	11.96 ...	14.53
Barley ...	15.2 ...	13.5 ...	12.77 ...	15.65 ...	13.84
Oats	12.8 ...	12 ...	10.80 ...	13.39 ...	11.51
Maize ...	41 ...	44.3 ...	39.60 ...	41.11 ...	49.27
Potatoes ...	51.37 ...	45 ...	36.4 ...	49.94 ...	46.26

1 metric centner = 2 cwt. (about).

With these details before us of the country's cereal production, it will be abundantly clear that there are opportunities for the installation of flour mill machinery, and, in fact, several flour mills have already been built with British installations, and I hear of at least three others which are proposed, and which will, of a necessity, require equipment. In other directions there will also shortly be a call for additional textile machinery, for, in spite of the fact that the past year was a critical one for the textile trade in most, if not all, of its branches, in view of the lower prices for yarn and the present abundance of skilled labour, together with the improved transport arrangements which are now provided, there is every reason to expect an extension of the textile industry. Brickmaking, which is another form of industry very largely pursued, necessitates the employment of the latest patterns of brick-making and brick hoisting machinery. Hitherto German patterns have been patronised, because the enterprising Teuton takes very good care to bring his manufactures prominently before the notice of possible consumers in this country, and he is assisted in his efforts by the fact that the German language is generally spoken, although, like the originators of that tongue, it is cordially and generally disliked.

There are at Budapesth several brick kilns, and last year they turned out 330,000,000 bricks, as against 260,000,000 bricks in the preceding year. It is understood that the present year will mark a very great advance upon the number of new buildings erected, a fact which one can readily ascertain for himself by observing the immense amount of activity both in the Capital and elsewhere. Already there have been orders for over 180,000,000 bricks booked, and it is expected that twice this number will be required to meet the present and future demands.

Among other factories, some few of which have been equipped either wholly or in part with British machinery and apparatus, are two prominent ironworks, one paper mill, one chemical works, two cloth mills, and two textile factories. Railway construction is also proceeding more actively, several small but important lines having recently been finished, and others commenced. Some 364 kiloms. of new State railway are to be built, including a section between Ogulin and Knin, with branches to Bihac and Otacac. The call for outside railway rolling stock is not very large, since there exist here at least two well-managed and admirably equipped factories, which, last year, built 230 locomotives, 360 passenger carriages, between 160 and 170 guards' vans, and considerably over 2000 goods and cattle trucks.

Reference has been made to the Hungarian iron and steel imports from Great Britain, but it is necessary to add that these would have been much larger but for the fact that local enterprise has been greatly supported, especially by the Government, so that Hungary is becoming more and more independent of such foreign imports. At the present time there exists a very large demand for iron and steel articles used in building construction, and the local foundries are fully occupied with orders in hand. During the past year the production of iron ore exceeded 20,000,000 centners, say 2,000,000 tons.

Sugar machinery is yet another speciality which should do well in Hungary, since the sugar industry is a highly profitable one. Nevertheless, as has been noticed in the Republic of Peru, South America, many of the mills are fitted with very antiquated machinery, the greater part of which has not been renewed, I should say, for several decades. Four other mills are in immediate prospect, so that manufacturers of sugar machinery would do well to place themselves in communication with the British Consul-General, whose name I have mentioned above, or with the Consul, Dr. Ignatz Brüll, at the address,

8 Zoltán Utcza, Pest, Hungary. In 1908 there were twenty-two sugar factories in existence, the number being increased in 1909 to twenty-three, and the production of sugar also increased for the same period from 3,087,196 centners to 3,205,031 centners. With regard to flour mills, there are to-day some 357 in existence and several new mills are proposed.

APPROXIMATE STABILITY.

By ARTHUR R. LIDDELL, Charlottenburg.

CALCULATIONS of stability as usually made involve a good deal of laborious and tedious work. They are met with principally amongst the contract plans of higher class vessels, which, in a relative sense, can be made at leisure, and in the form of specially prepared evidence material submitted to the Wreck Commissioner's Court after accidents.

Approximate curves of levers would certainly be extensively used in designing if they could be quickly obtained, and for this purpose the tables and methods of applying them to be described in the following have been worked out.

If the effect of sheer and erections be in the meantime neglected, the stability of a vessel with flattish floor and

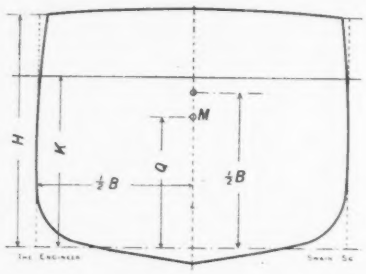


Fig. 1

fullish ends will vary very little from that of a rectangular block, the section of which has the breadth and area of the midship section of the vessel up to the gunwale, as shown in Fig. 1.

The base line of the block is then correspondingly higher than that of the vessel.

The conditions of transverse stability of the block are, of course, the same as those of its section, and the positions of the centres of area of the surfaces immersed at different draughts of water and different angles of inclination are readily found either graphically or by calculation.

If H be the height of the block,
K the draught from the new base,
D the difference between H and K,
a the vertical side of a corner triangle (Figs. 3 and 5),
$= \sqrt{2} \times \tan \alpha \times$ area of triangle,
b the horizontal side of the same triangle,
$= \sqrt{2} \times \cot \alpha \times$ area of triangle,
and α the angle of inclination,

the lever l is for the condition illustrated by

Fig. 2 $= \left[\frac{1}{3K} + \frac{\tan^2 \alpha}{6K} - \left(1 - \frac{K}{2}\right)\right] \sin \alpha,$

Fig. 3 $= \left(1 - \frac{b}{3}\right) \frac{D}{K} \cos \alpha + \left[\frac{D}{2} - \left(\frac{H}{2} - \frac{a}{3}\right) \frac{D}{K}\right] \sin \alpha - \left(1 - \frac{K}{2}\right) \sin \alpha,$

Fig. 4 $= \left(1 - \frac{K}{H} - \frac{H^3}{48K} \cot^2 \alpha\right) \cos \alpha + \left(\frac{H - K}{2} - \frac{H^3}{24K} \cot \alpha\right) \sin \alpha - \left(1 - \frac{K}{2}\right) \sin \alpha,$

Fig. 5 $= (\tfrac{1}{3} a - \tfrac{1}{4} K) \sin \alpha + (1 - \tfrac{1}{3} b) \cos \alpha - \left(1 - \frac{K}{2}\right) \sin \alpha,$

Fig. 6 $= \frac{\text{Breadth} - \text{Height}}{2}$ or $= 1 - \frac{H}{2}.$

In the preparation of the tables from the foregoing formulæ the centre of gravity for every height is assumed to be at a point on the centre line of the rectangle at a distance equal to half its breadth above its base. All measurements are in terms of the half-breadth of the block as the unit. Positive levers are denoted by the sign + and negative ones by −. The figures given are obtained partly by calculation and partly by interpolation.

Table I. contains values of the levers of rectangles inclined to an angle of 30 deg. for heights and draughts ranging up to 2.0 and 1.9 respectively, the whole height of a square-sectioned block being equal to 2. Table II. contains values of the levers for an inclination of the rectangle to 60 deg. The curve of levers for the equivalent block of a given vessel (see Fig. 1) may be obtained as follows:—

The height and draught of the block respectively must first be divided by the half-breadth in order to reduce them to the scale of the rectangle, for which the tables are made out. The tabular values of the levers corresponding with these latter must then be enlarged again to the scale of the vessel.

The lever for 90 deg. is in all cases the difference between the half-breadth of the block and the distance of its centre of buoyancy in the inclined position from the corrected base line.

The initial angle of the lever curve is obtained as follows:—At the 57 deg. point on the base line and above or below the latter, according as the stability is positive or negative, a perpendicular distance equal to that of the centre of gravity of the block from the metacentre is set off. A straight line connecting the offset point with the zero point of the curve will give the initial angle of the latter. With the three points and the initial angle thus obtained the lever curve may now be drawn with tolerable accuracy. The curve will be correct for the block, and approximately so for the vessel up to the point at which the gunwale becomes immersed, and the deviation will be practically unimportant for a few degrees of further inclination. The actual or assumed height of the centre of gravity and the influence of the sheer have still to be allowed for as follows:—

Above that already obtained a new curve of levers may be set off for a block that is higher than the one hitherto made use of by, say, one-third of the mean amount of the sheer of the vessel. Since the side from the gunwale up to this point is hollowed out in the middle, its stability value is diminished—perhaps by one-half. At the angle of inclination, then, at which the water-line would pass through the one-third-sheer point of the vessel's side, the correct point for the block with sheer will be about midway between the two lever curves. If the centre of mean

TABLE I.—*Righting Levers for an Inclination of 30 deg. in Terms of the Half Breadth of the Vessel or Block.*

Draught of block ÷ half breadth.	Height of block ÷ half breadth. 2·0	1·9	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·1	1·0	·9	·8	·7
1·9	+·0108													
1·8	+·0155	−·0068												
1·7	+·0156	−·0056	−·0293											
1·6	+·0114	−·0037	−·0263	−·052										
1·5	+·0027	−·0061	−·0223	−·044	−·072									
1·4	−·0111	−·0132	−·0226	−·040	−·064	−·0945								
1·3	−·0254	For all heights of block.	−·0287	−·0378	−·0565	−·0843	−·114							
1·2	−·0380			−·0427	−·0514	−·066	−·100	−·134						
1·1	−·0482				−·0510	−·0622	−·082	−·116	−·154					
1·0	−·0555					−·0585	−·0717	−·0959	−·1321	−·1722				
·9	−·0589						−·0623	−·0764	−·1019	−·142	−·186			
·8	−·0569							−·0614	−·0771	−·1074	−·151	−·200		
·7	−·0472								−·0515	−·0703	−·1049	−·1565	−·2139	
·6	−·0259									−·0359	−·0528	−·1074	−·1535	−·2204
·55	−·01													
·50	+·01													
·45	+·03													
·40	+·05													
·35	+·072													
·30	+·095													
·25	+·122													
·20	+·149													
·15	+·174													
·10	+·200													
·05	+·26													

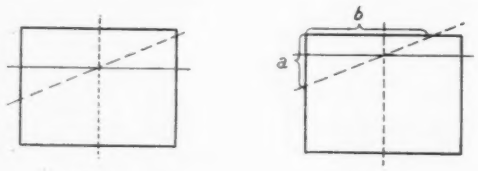


Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6

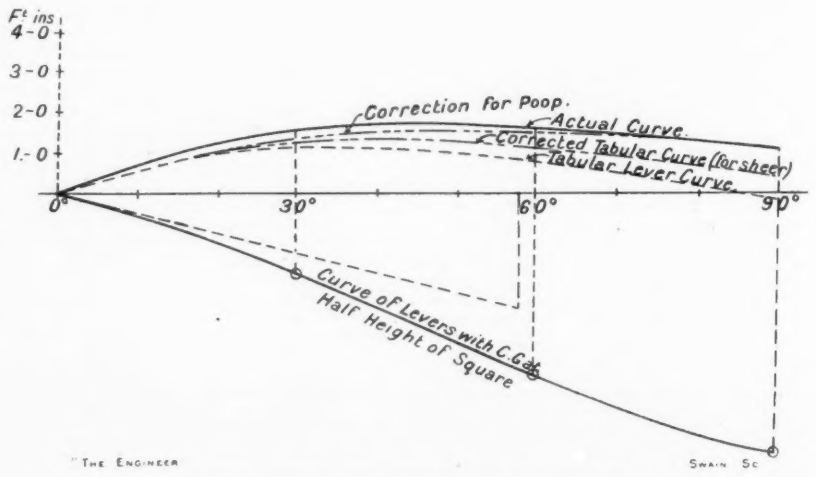


Fig. 7—CURVES OF RIGHTING LEVERS OF A SAILING SHIP

distances of the block with sheer be obtained—approximately it is at half height between the base of the block and the one-third-sheer point above mentioned—its distance below the assumed centre of gravity at distance equal to the half-breadth of the block above its base, if set off below the base line at 90 deg., will give the end-point of the curve.

If the real centre of gravity be at a distance d below the assumed one, heights equal to d sin 30 deg., d sin 60 deg., and d sin. 90 deg. set up above the curve at these angles will give points in a new curve which will be the curve of levers for the block with sheer. For vessels of ordinary form without extravagances in any direction or excrescences such as external sleeves for the shafting, pronounced club feet, or the like, the actual curves will, indeed, differ from this, but the differences will not be very great. They will vary somewhat for the models of different designers; but with a little experience a designer will know what allowances to make for them in his own vessels. Moreover, for a great many cases the degree of accuracy attaching to the uncorrected curves will be quite sufficient. Figs. 7 and 8 illustrate the system generally, and give graphical expression of the lever curves obtained by it for a sailing vessel and for a steamer, both in loaded condition. The actual curves as obtained by the ordinary methods of calculation are also given for the sake of comparison.

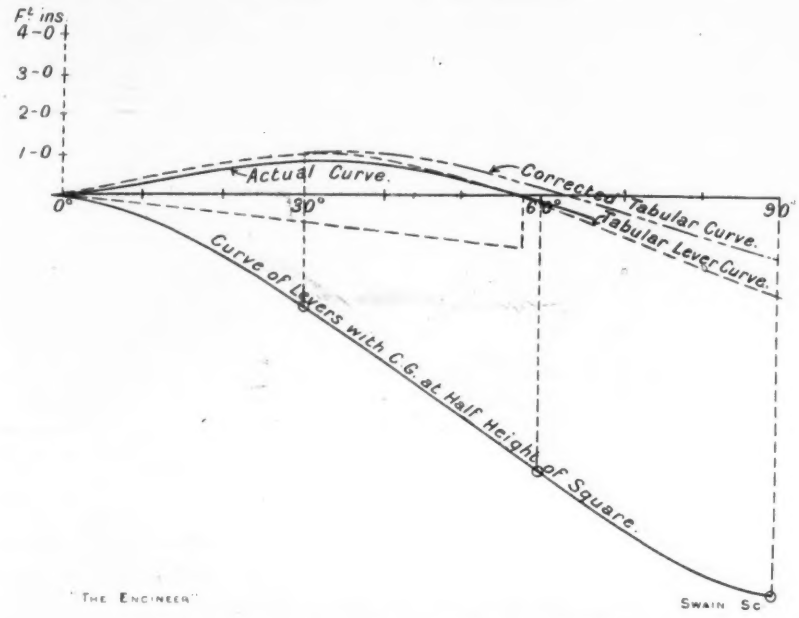


Fig. 8—CURVES OF RIGHTING LEVERS OF A STEAM SHIP

The effect of an appendage of large size below water or of a deck-house not included in the first calculation may be determined with a degree of accuracy sufficient for many purposes by multiplying its displacement by its distance from the centre of buoyancy of the moulded displacement in a direction parallel with the inclined water-line at any given angle and dividing the result by the whole displacement, including that of the part added. The result will be the amount by which the lever is shortened or lengthened, as the case may be.

It will have been observed that the use of the metacentre has, except in the obtainment of the initial angle of the lever curve, been avoided in the foregoing. Inasmuch, however, as this point bears a certain relation to the lever curves, and is generally dealt with in connection with these, the following approximate method of readily finding it may not be out of place. It is known from experiment that the heights of the metacentres for different water-lines of an actual vessel do not differ greatly from those of the equivalent block. Now, inasmuch as the height of the metacentre for the different water-lines of the block or of the equivalent rectangular midship section is independent of the height of the part of the block above these water-lines, it becomes easy to draw up a universal table for it. The accompanying Table III. is based on the formula:—Metacentre (M) above centre of buoyancy (B M) $= \left[\frac{2}{3} \times \left(\frac{\text{Breadth}}{2}\right)^3\right] \div$ (Area below water-line). For the height of M above the bottom of the block, the half height of the latter up to the water-line in question is then added. The metacentric height coefficient given in the table, multiplied by the half-breadth of the vessel, as in the case of Tables I. and II., will give the height of the metacentre of the block above the corrected base line. Needless to say, the block metacentres will coincide approximately with those of the vessel only so long as the midship breadths of the water-lines in the two cases are about equal.

TABLE III.—*Metacentres of Rectangular Blocks.*

Draught in terms of half-breadth of block.	Metacentre coefficient.	Draught in terms of half-breadth of block.	Metacentre coefficient.
2·0	1·167	1·0	·833
1·9	1·125	·9	·820
1·8	1·086	·8	·817
1·7	1·046	·7	·826
1·6	1·009	·6	·865
1·5	·972	·5	·917
1·4	·938	·4	1·033
1·3	·906	·3	1·261
1·2	·878	·2	1·767
1·1	·853	·1	3·383

TABLE II.—*Righting Levers for an Inclination of 60 deg. in Terms of the Half Breadth of the Vessel or Block.*

Draught of block ÷ half breadth.	Height of block ÷ half breadth.																		
	2·0	1·9	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·1	1·0	·9	·8	·7	·6	·5	·4	·3	·2
1·8	− ·015	− ·052																	
1·7	− ·018	− ·055	− ·094																
1·6	− ·011	− ·052	− ·100	− ·136															
1·5	− ·009	− ·044	− ·090	− ·139	− ·175														
1·4	+ ·011	− ·025	− ·077	− ·124	− ·168	− ·216													
1·3	+ ·025	− ·011	− ·057	− ·105	− ·150	− ·205	− ·256												
1·2	+ ·038	+ ·002	− ·038	− ·082	− ·131	− ·182	− ·240	− ·295											
1·1	+ ·048	+ ·015	− ·021	− ·060	− ·107	− ·150	− ·216	− ·273	− ·334										
1·0	+ ·056	+ ·027	− ·006	− ·041	− ·085	− ·130	− ·184	− ·240	− ·305	− ·371									
·9	+ ·059	+ ·030	+ ·006	− ·030	− ·065	− ·107	− ·152	− ·209	− ·268	− ·335	− ·412								
·8	+ ·057	+ ·038	+ ·014	− ·013	− ·048	− ·085	− ·128	− ·177	− ·230	− ·290	− ·364	− ·453							
·7	+ ·047	+ ·036	+ ·016	− ·008	− ·032	− ·070	− ·106	− ·148	− ·200	− ·254	− ·316	− ·391	− ·475						
·6	+ ·026	+ ·021	+ ·011	− ·005	− ·027	− ·055	− ·087	− ·126	− ·166	− ·217	− ·273	− ·340	− ·415	− ·498					
·55	+ ·009		− ·009	− ·017	− ·028	− ·048	− ·073	− ·104	− ·142	− ·183	− ·236	− ·290	− ·356	− ·433	− ·522				
·50	− ·008				− ·047	− ·060	− ·072	− ·094	− ·118	− ·152	− ·194	− ·242	− ·301	− ·375	− ·447	− ·547			
·45	− ·027						− ·089	− ·098	− ·111	− ·134	− ·163	− ·202	− ·249	− ·301	− ·379	− ·460	− ·573		
·40	− ·046								− ·140	− ·142	− ·155	− ·176	− ·247	− ·242	− ·299	− ·365	− ·451	− ·573	
·35	− ·067												− ·206	− ·218	− ·242	− ·280	− ·333	− ·409	− ·531
·30	− ·089																		
·25	− ·114																		
·20	− ·140																		
·15	− ·173																		
·10	− ·206																		
·05	− ·253																		

For all heights of block.

L, and the displacement D are given, but the lines are not drawn, the formula

$$BM = \frac{L\,(a - \frac{1}{2})\,b^3}{D}$$

for the equivalent trapezium may be applied. The result in this case is somewhat too great.

Where the displacement scale exists, the height of the centre of buoyancy below any given water-line is, as is well known, equal to the mean height of the curve up to that water-line, which may be found by short methods that will readily occur. In order to obtain the vertical height of the centre of the whole vessel, it may often be of advantage to extend the calculation of displacement right up to the highest point of the deck (at the stem of the vessel). This is useful in the calculation or approximation of the righting lever of the vessel when she is inclined to an angle of 90 deg. The 90 deg. water-line of loaded vessel is, as a rule, not far from the centre line of the vertical position, and the distance of the centre of buoyancy of the whole or of the half-ship from the top of the keel may usually be taken without correction for that of the vessel thus inclined.

As an approximate method of finding a point on the lever curve for an angle, say, of 30 deg., the following modification of the wedge method of Atwood may be applied.

If the inclined water-line be drawn on the body plan, sectors of circles equivalent to the wedges cut off at the different sections may be sketched in. The moments of these sectors may then be substituted for those of the actual wedges in the calculation. The moment of any given sector of radius r shifted across the vessel is equal to

$$\text{Area of circle with radius } r \times \frac{\text{angle in deg.}}{360} \times 2\,r \times \tfrac{2}{3},$$

$$\text{or to } \frac{4}{3}\,\pi\,r^3 \times \frac{30}{360} = \frac{\pi\,r^3}{9} = .35\,r^3.$$

The moment of the wedges for an angle of 30 deg. is equivalent to .35 times the sum of the cubes of the radii of the different sections.

The moment thus found may be corrected, if necessary, in the usual manner, and divided by the function of the displacement in order to obtain the lever for the curve.

This method applies to the case of a small inclination, at which the deck edge is not yet immersed. One point thus found will often yield all the information required from the lever curve.

The angle of 30 deg. is a convenient one to work with because its sine ($= \frac{1}{2}$) is a simple fraction and alterations of the G M height divided by two are equal to the corresponding alterations to the lever at this angle.

An approximate method similar to that for the transverse conditions may also be applied in dealing with the longitudinal stability. The equivalent block may in this case be constructed somewhat as follows:—

The bottom of the vessel being raised as in Fig. 1, and a new base-line drawn parallel with the keel, the ends of

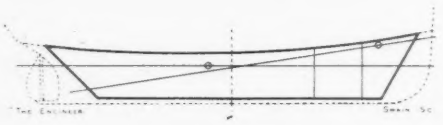


Fig. 9

the water-line aft and forward may be "squared," and inclined straight lines drawn through the end points of the shortened length on the longitudinal section plan at angles with the vertical corresponding as nearly as possible with those of the mean buttock and bow lines respectively. These inclined lines with the new base and the curved deck-line together form a four-sided or equivalent block figure of uniform breadth for the determination of the longitudinal stability—see Fig. 9. If this equivalent block be now careened longitudinally, the point of intersection of the inclined water-line with the original horizontal one will lie towards the immersion side of the centre of mean distances of the latter. For equal total displacements the immersed and emerged wedges will be equal, and since the triangles representing these are easily compared, the cutting points may very readily be found. Now, if we assume a compartment, say, in the the fore-hold, to have become open to the sea, the volume of water which will enter it can be nearly determined without the upper surface being exactly fixed. This volume, divided by the area of an inclined water-line of the block passing a little below the gunwale forward, will give the thickness of the correcting layer due to the inrush of water into the damaged compartment. It will probably be most convenient, and it will often be sufficiently accurate to make a mark on the longitudinal plan near the fore end at a distance below the top of the deck equal to this latter thickness, and to use it as the limit of inclination in the further operations, instead of working with a correspondingly deeper water-line. An inclined water-line may now be drawn through this limiting point so as to cut off immersed and emerged triangles that are equal to one another.

To determine whether, with the additional water in the damaged compartment, the vessel will incline to a greater or to a less degree than this, the moment of the added volume of water taken about the original centre of gravity must be divided by the displacement. The quotient divided by the height of the longitudinal metacentre above the centre of gravity will give the tangent of the angle of inclination required.

The height of the metacentre may be obtained by the use of the tabular coefficient, that of the centre of gravity above the "new base" being deducted. For the vertical position of the centre of gravity, a rough approximation is all that is required, a difference of a foot or so making no appreciable difference in the result.

THE CAUSES OF RIVER DEVIATION.

By T. S. ELLIS.

A BOOK reviewed in THE ENGINEER of September 8th[1] contains an interesting account of the almost complete destruction of Dera Ghazi Khan by the westward deviation of the Indus. Its history, as told in the newspapers,[2] is a romantic one. Ghazi Khan, the founder 400 years ago, "laid his tomb" on higher ground near, having been "warned in a dream that his town would be eaten up by the Indus." This was fulfilled, or nearly so, in 1910, about 5000 houses out of 6000 being destroyed. The relative positions of town and river in 1865 are shown in Fig. 1, taken from the Survey map of the ¼in. scale.

The author of the book admits that "the causes of the westward movement are not known." He states, however, that the forests on the east of the Indus must have a tendency to prevent the stream from moving to the east, and adds, "The stream must, like all other streams whose velocity is too great for its bed, make itself crooked in order that the slope may be flattened and the velocity reduced"; and, further on, "Unable to form the bends by cutting to the east it cuts to the west" (page 6). But, surely, if water flow down an inclined plane it will, in the absence of a diverting influence, flow in a straight line, and the greater the velocity the more will removable obstructions be overcome, and the straighter will the stream flow. Rivers do sometimes flow for a short distance in a remarkably straight and constant line; the author mentions an instance of this, six miles in

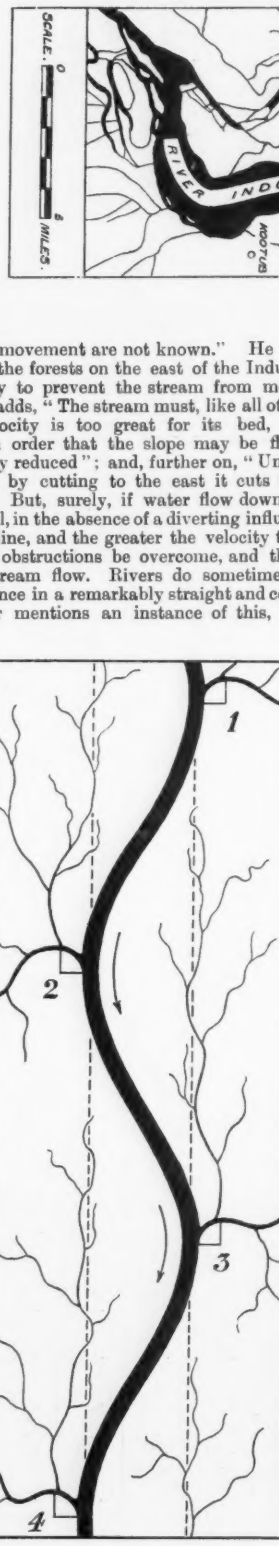


Fig. 2

length, on the Ravi. In such cases the student of rivers will do well to search not so much for causes which compel the river to go straight as for usually-existing conditions, the absence of which may have left it free to do so. Clearly, as rivers almost always either wind or, in beds too wide for them, wander in multiple channels, the cause of these features must be almost universally present.

Rivers not only drain the country from which they come, but also that through which they pass; they receive tributaries, and these must either go to the river, flowing in a straight line, or the river must turn from side to side

[1] "Punjab Rivers and Works," by E. S. Bellasis. Printed at the Pioneer Press, Allahabad.
[2] *Standard*, October 27th, 1910.

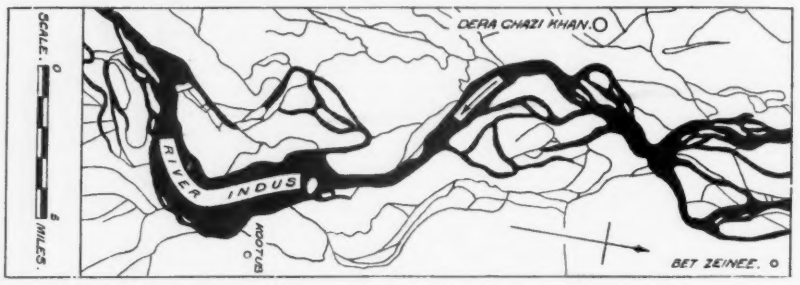


Fig. 1

and meet them. Very nearly thirty years ago the present writer discussed, in a paper printed at the time[3], the influence of tributaries on the winding of rivers in alluvial plains. The argument was that a tributary, falling into the river, cuts through the bank and weakens it so that erosion more readily takes place; and not only so, it keeps open a channel on its own side. "This the river adopts for itself, and is thus diverted towards the side on which the tributary falls in."[3] Obviously, too, the more the one bank is eroded the more the river is directed against it. In applying this to the Indus, one finds that while many streams coming down from the Sulinam Mountains, twenty or thirty miles away, fall in on the right side, the area drained on the left side is very small, as the Chenab River flows nearly parallel at a short distance. Thus an explanation is suggested for the westward deviation.

The course of a river at a given point must depend on the predominance of one or more of the various causes which may serve to direct it. One element is always present—the tendency of the river to go in a straight line down the plane over which it flows, and thus to go to its destination by the shortest route. The low-water channel of a diverted river may follow a great curve, say to the right, round a bank of river deposit, and this course may seem to be permanent. But at flood time, when volume and velocity have suddenly increased, the current going straight across the curve may make or renew a channel in that line, and this becomes the principal one. Erosion may then be greater on the left bank, with consequent deviation to that side. This will go on until other causes, not always apparent, bring about reversion to the former course.

The author remarks, page 2, that "erosion of the bank may be predicted if the stream be much curved, but not with certainty." This recognises a fact of great importance; for if the direction of the stream, the degree of velocity, the curve of the bank and the soil of which it is composed be all known, the question whether erosion will occur or not would seem to be easy. On what conditions, then, does the answer depend? If the bank be broken by openings for inflowing or outflowing streams, it will be more easily eroded than if it be continuous. So, too, if the stream below the point of impact in the curve be still continued in direction along the line of the bank, erosion may be expected to a greater extent than if the stream flow freely away from this bank towards the opposite side of the river.

This is due to an influence of which the importance seems to be repudiated by the author—page 6—the traction influence or "draw" of flowing water on that flowing behind it. We know that if two streams flow at a moderate distance from each other down a smooth, evenly inclined plane, corresponding to the broken lines in Fig. 2, they flow in parallel lines, and everyone will admit that they do this in obedience to the law of gravity. Now if one stream be obstructed and guided over to the other the two will unite and flow together. They will continue united even if the obstruction which led to the union be removed and the force of gravity left free to operate as before. Just as the surface-tension of the water in the two streams had to be overcome before they united, so the cohesion in the water of the united stream would have to be overcome before it could divide. The traction influence of the united stream prevails over the force of gravity. And so, if a stream be flowing away from a bank the pressure and consequent erosion will, at any rate, be less than if it be directed towards or even in a line parallel to the line of the bank. Unless this influence be recognised it would in some cases be difficult or impossible to explain why erosion does not occur, and in others why it does not go on indefinitely.

One observation only will be made on the costly defences constructed during many years as a means of saving the town. All of them are shown as being either in a line with the bank or at right angles to it. So far as appears, no attempt has been made to deflect the stream, as is sometimes done by the erection of a groyne at an angle of about 30 deg. with the line of bank below, 150 deg. with that above, thus guiding the stream along an inclined line towards the opposite side. Fig. 2[4] is intended to represent a model river in which the channel, once formed, will not change. The lines of the two banks are unbroken except at fixed points. The tributaries on both sides enter only at the fixed points shown by quadrant shaped areas indicating piers 1, 2, 3, 4, which may or may not be necessary to keep the points fixed. Tributaries have been mentioned as disturbing elements, as, indeed, they generally are; here they are used for a beneficial purpose. The tributary stream, uniting with the river, corrects any disposition the latter may have to go over towards the opposite side, and to follow the line shown as broken, while the pier prevents

[3] "The Severn Valley near Gloucester." School of Science. Philosophical Society. February, 1882.
[4] For both of the excellent drawings the writer is indebted to Mr. W. E. James, an engineer on the staff of the Derbyshire County Council.

deviation of the river towards the tributary. The union of these two streams ensures water opposite the piers, specially important if they be used as landing-places for boats. One or more additional fixed points, if required, may be on the same side before the river crosses over to the other. Fig. 2 is closely in accord with Nature; there is something very like it on the Thames above Marlow. Tributaries generally fall in on the convexities of curves; in other words, rivers generally incline towards them.

The arrangement shown in Fig. 2 may be seen even in tidal rivers. The estuary of the Exe is a good illustration. The low-water channel is by the left bank at Topsham; it swings over to the right and receives a stream flowing in by the canal opening; then it passes over to the left and receives the Clyst, and again goes over to the right and receives the Kenn. The tide would go straight, as indicated by tongues of the early tide seen as impressions in mud banks, of which Powderham Pool is an example. All this is shown in a map illustrating a paper in the *Geological Magazine* on "The Low Water Channels in Rivers and Estuaries."[5]

The rivers of India are sometimes said to be so very different from those in England that no conclusions ought to be drawn from comparisons. But abundant evidence goes to show that similar conditions in both countries result in the formation of similar features. In THE ENGINEER of June 2nd, 1911, page 563, the outline of the Rangoon River at the Port of Rangoon is shown. If the relative directions of tide and stream be reversed the resemblance to the expansion of the Mersey above Liverpool is very striking; while the Weaver and the Gowy are represented by two large streams curving in the convex side. When Fig. 2 was designed there was no thought of the Indus, but if the part of it near to Dara Ghazi Khan, as seen in Fig. 1, be regarded with Fig. 2, little imagination is required to see a disposition to go on the same plan. To propose the application of the principle of Fig. 2 might indeed be presumptuous, and, of course, modifications of detail would have to be made. This much, however, may safely be said. A river such as the Indus cannot be brought under control unless some points be firmly fixed, nor unless tributary streams and irrigation canals be, except at fixed points, cut off from the main line of the river.

A careful study of rivers and their ways may enable an observer to make a prediction as to conditions which must exist, although not shown on a map. In January, 1905, the late Mr. Vernon Harcourt read a paper before the Institution of Civil Engineers on the river Hooghly, and in the discussion observed that the present writer had, "even in some parts of the Hooghly, to assume the existence of tributaries which did not appear on the charts."[6] This related to the charts printed with the paper, of which a proof had been issued. In some notes sent to Mr. Vernon Harcourt, on his written invitation, the much-dreaded James and Mary Shoal was mentioned as a shoal in mid-stream, with a channel on either side, indicating some need for a channel along each bank. The absence of anything in the line of the tide, or in the main line of the stream, to cause this eastern channel seemed to justify a confident assumption, based on no other evidence, that it was caused by tributary streams not shown on the charts. A survey map afterwards obtained showed them to be present. Moreover, in the dry season, when no local water flows in, this eastern channel does partly close, so that the suggestion to divert the tributaries was really one to perpetuate a condition which, in the dry season, actually existed. Or, in other words, to make the undesirable channel unnecessary was suggested as a first step towards closing it.

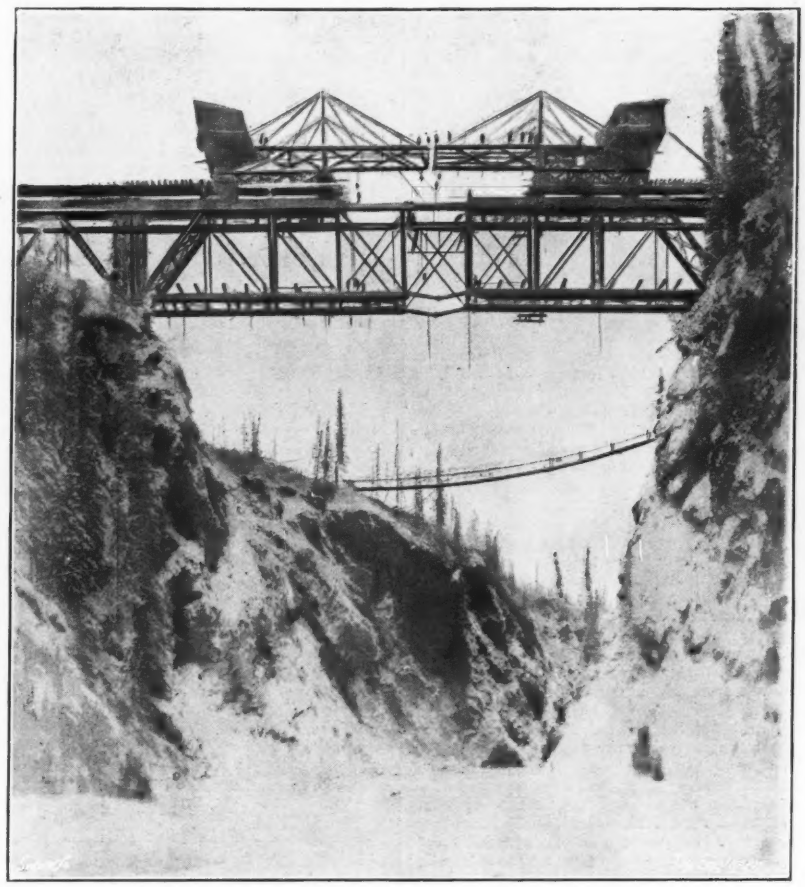
A reliable copy of an Admiralty chart was published in the *Geological Magazine*[7] to illustrate the paper already mentioned. This chart served to make clear that all along the river from Calcutta to Hooghly Point one or other of these conditions existed. (A) No stream coming in on either side—a straight, well-defined channel. (B) Streams coming in on one side only—a well-defined channel on that side only. (C) Streams coming in on both sides—an ill-defined channel and a disposition to form a shoal in mid-stream.

The same paper contained a diagram practically identical with Fig. 2, and an admission was made that if in a case where the conditions were fulfilled the river continued to change its course, a confession of error must follow. The admission is repeated now.

BRIDGE BUILDING IN ALASKA.

No. III.*

THE branch line of the Copper River and North-Western Railway to the Bonanza Copper Mine, after crossing the Copper River between the mouths of the Chitina and Kotsina rivers, follows up the Kotsina slope for a distance of about three miles, where it crosses a low divide between the Kotsina and Chitina rivers, to the Chitina slope, which it follows to the Kuskulana River, crossing this stream about eight miles above its confluence with the Chitina and 149 miles from Cordova, the coast terminus of the railway. At the point selected for this crossing, the Kuskulana flows through a gorge having rock walls and being 190ft. wide and 175ft. deep. The elevation of the line was fixed with the base of the rail 240ft. above the bottom of the gorge, the gradient being level and the bridge on tangent. The climatic conditions at this bridge site are very different from those of the Flag Point Hot Cake Channel and Miles Glacier bridges. The annual precipitation is light, winds during the winter are practically unknown, and the temperature is much lower in the winter and higher in the summer than that of the coast country. In the winter of 1910-11 the lowest recorded temperature was −67 deg. Fah., and in the summer of 1910 the highest temperature was + 96 deg. Fah. in the shade. After an examination of the site, it was decided that the span over the gorge should be a deck span 225ft. long, and be designed to be erected as a cantilever, two deck spans of 150ft. each, to be erected on shore on each side, and to be used as anchor spans, each end of the 225ft. span, and the adjoining end of the 150ft. span, to be supported by a steel tower, the shore ends of the 150ft. spans to rest on concrete piers.



THE KUSKULANA BRIDGE—DECEMBER 29th, 1910

Practically all the country in the immediate vicinity is covered with tundra—partially decayed moss and other vegetation—from 1ft. to several feet in thickness, and the ground wherever the tundra occurs is perpetually frozen in most cases to bed-rock, regardless of the depth. This made the preliminary digging of test pits rather tedious, but they were completed during the latter part of October. In December, 1909, the railway was completed to Tiekel, 101 miles from Cordova, the track material and other supplies being ferried across Miles Glacier Lake—a widening of Copper River—above the site of the Miles Glacier Bridge.

The cement for this work was purchased in Seattle in November, 1909, the barrels being covered with canvas to protect the contents from moisture. It was intended to ship this cement to mile 101 during the autumn, and to haul it to the bridge site over the ice when the river froze; but lack of warehouse room at mile 101 prevented this being done.

The track between Miles Glacier and Tiekel was laid temporarily on the ground surface, and water flowed over these portions of the track from 1ft. to 2ft. in depth, ice from 4in. to 6in. forming on the surface of this water. This, together with snow-slides, heavy snowfall, and scarcity of fuel on the north side of the Copper River, and the necessity of preference being given to food supplies for the front, prevented the cement reaching Tiekel until the middle of April, 1910, when the ice in the river had become unsafe for teams to travel over it. Three stern-wheel steamboats had been built by the Katalla Company on the Copper River in the spring of 1909 to distribute construction supplies. On account of the channels continually shifting, the swift current and the high winds on the upper river, this was both a costly and tedious method of handling supplies, but it was the only possible way of delivering material ahead of the line. After the ice was out of the river the cement was shipped by steamer to mile 133, near the mouth of the Chitina River. From this point a wagon road had been

THE KUSKULANA BRIDGE—JANUARY 3rd, 1911

[5] Decade 5th, Vol. V., No. 532, October, 1908.
[6] "Proceedings," Institution of Civil Engineers, Vol. cliv., Part II. 1904-5, pp. 71, 105.
[7] October, 1908.
* No. II. appeared December 8th.

constructed for delivering supplies as far as Kuskulana, and the cement was hauled by team to the bridge site, a distance of 16 miles. The cement delivered at the bridge site cost the company 85s. per barrel.

On April 1st, 1910, a party of engineers left Miles Glacier camp for Kuskulana. The train on which they started was delayed by ice over the rails where the track had been left low, and by the rotary snow plough breaking down, so they left the train about mile 70, and, using snow shoes, pulled their tents and engineering equipment on hand sleds to Kuskulana, reaching there on April 10th. Fifteen labourers and carpenters followed them, leaving Miles Glacier camp about the middle of April and hauling their blankets and tools the entire distance of 100 miles on hand sleds. As all the structural steel, cement, and other material was delivered on the south side of the river and half of all material would have to be used on the north side, a 1¼in. steel cable supported on wooden towers built of the spruce trees cut in the vicinity of the site was determined upon for transferring materials across the river. About April 27th the excavation for foundations was begun, as was also the getting out of the timbers for the towers and for the falsework on which to erect the anchor spans. In excavating for the concrete foundations the tundra was first removed from the ground, and when the latter ground had thawed down from 6in. to a foot the thawed ground was removed, and the uncovered soil was left for two or three days to thaw. When bed rock was uncovered in August at the site of the tower pedestals, it was found to be so badly frost-cracked that the excavation had to be carried down from 6ft. to 16ft. farther than had been planned.

The cost of cement delivered at the Kuskulana River made prohibitive the building of the pedestals the additional height. The American Bridge Company, which had the contract for manufacturing the superstructure, was advised of the necessary additional lengths required for the columns, but as the delivery of the entire order of steel for this work would have been delayed until cold weather by having the necessary changes made, the order for the additional column lengths was placed with the North-West Steel Company, of Portland, Ore. The concrete foundations, the falsework for the anchor spans, and the towers for the cableway were all completed early in September. The line was laid to Kuskulana on October 18th, but on account of cars not being immediately available to load all the material and equipment, the camp was only moved from Miles Glacier to Kuskulana on October 26th.

Fortunately, the weather was much milder than usual, and instead of the temperature being from 20 deg. to 30 deg. below zero, it ranged from zero to 30 deg. above. The only serious hindrance at this time was the small amount of daylight, there being only about 4½ hours between sunrise and sunset. This decreased to about three hours in December. On account of the extremely cold weather, which was certain to come before the steel could be erected, all the boilers and engines were housed, and on this account, and also because of the great lift necessary to raise water from the Kuskulana River, it was not deemed practicable to obtain the water necessary to supply the engines and the camp from this source. Accordingly, a water tank was erected on the south side of the river, with steam pipes leading into it to keep the water from freezing. This tank was kept supplied by a locomotive which brought the water from mile 146. Two 2in. pipes for water and compressed air, with a live steam pipe on each side of them, were packed with hay in a 12in. casing, which was swung under a suspension footbridge over the gorge, for supplying water and compressed air for the far side of the river. Provision was also made for blowing steam through the 2in. water pipe as soon as a supply of water had been pumped across the river. Even with these precautions a great deal of delay was caused by the water and air pipes freezing when the cold weather came. The temperature during the erection of this bridge ranged from 30 deg. above zero to 54 deg. below zero Fah., the cold weather beginning in the latter part of November.

The camp and overhead travellers were erected and work on the steel erection begun on November 8th. Erection was carried on simultaneously from each side by means of two overhead travellers, half of the steel, about 541 tons, one traveller and four hoisting engines being transferred across the river over the cableway. The steel for the cantilever span was taken out to the travellers on a track laid on the lower chords of the spans. The two 150ft anchor spans and the steel towers were first erected and riveted, the fixed end of each anchor span being next to the 225ft. span. After the anchor spans were erected 50 tons of steel rails were placed on the outer end of each one of them for counterweights during the erection of the cantilever span.

The plan followed in erection was as follows:—The top chords of the two 150ft. anchor spans were connected by temporary bars to the top chords of the corresponding halves of the span to be cantilevered. These bars being 4ft. 9$\frac{13}{32}$in. centre to centre of pinholes at the expansion end of the 225ft. span and 4ft. 8$\frac{11}{32}$in. at the fixed end, the normal distance between the centres of end pins of the two spans being 5ft. The end shoes of the two spans at the fixed end of the cantilever span were kept in place by built up compression blocks between them, while at the expansion end of the 225ft. span cast steel guides were bolted to the end shoes of the two spans and a cast steel wedge driven between the shoes until the segmental rollers were turned as far toward the centre of the span as possible. The wedge had a 6in. steel shaft, 16ft. long longitudinally through its centre, the shaft being threaded for 6ft. on one end, and held in position by a jam nut at each end of the wedge. The wedges were operated by a reversible nut on the outer end of the shaft, and held in position by a yoke attached to the outsides of the end shoes by 6in. pins. This arrangement held the outer ends of the cantilevered span a little higher than normal, and shortened the distance between lower chord and pins, thus making it an easy matter to drive the pin in the middle of the centre panel of the lower chord.

After this pin was driven, and the middle sections of the upper chords were in position and fully bolted at one end, the wedges were drawn slowly. At the same time the outer ends of the anchor spans were jacked, and the adjustable bars in the centre panel were always kept under tension until the unbolted ends of the top chord came into position, so that they could be fully bolted. The same operations were continued until the span was swung, the final connection being made with the thermometer registering 40 deg. below zero. The temporary bars connecting the anchor spans and the cantilevered span were then cut, and the shore spans lowered into position. The travellers were removed, and the bridge was ready for trains to cross on January 12th, 1911, without any serious accident having occurred during the entire erection.

The construction of these bridges and the extensions of the Copper River and North-Western Railway, in Alaska, have been carried out by the Katalla Company, of Cordova, for whom Mr. E. C. Hawkins acts as resident and chief engineer, and Mr. A. C. O'Neel as bridge engineer.

LOCOMOTIVE EXHIBITS AT TURIN.

No. IV.*

One of the most interesting of the locomotives shown at the Turin Exhibition is an entirely new type of goods engine, with ten wheels coupled, built by J. A. Maffei, of Munich, for the Bavarian State Railways. Most of the locomotives exhibited embody nothing novel in their cylinder arrangement or their motion. For the most part they have the cylinder arrangement and rocker arm transmission for one pair of valves introduced by the late Mr. Webb in his four-cylinder compound type. This system of rocker arm in front of the cylinder is now considered a first-class arrangement for simple engines, as it saves two valve gears. At Turin the only locomotives not so fitted are the complicated French engines and the Bavarian engines now under consideration. Incidentally it may be remarked that in 1889 M. de Glehn, some years prior to Webb, proposed to use rocking arms as a simplification on the Nord compound locomotives, but these, being rejected, led to the complicated engine with one complete valve gear for every cylinder, now the standard practice in France.

In the new Bavarian engine these rockers are avoided altogether, and a valve distributing steam simultaneously to two cylinders is employed instead. This of itself is not a novelty, previous applications of the principle having been made by du Bousquet in 1888 and by Vauclain in 1902, while in 1899 Plancher combined the double valve with a receiver. In the new Maffei design, however, a voluminous receiver is neatly contrived within the space embraced by the two heads of the piston valve, and in this we have a distinct novelty. To secure this result annular steam receivers are formed around the barrel of the valve chest. These receivers are always in communication with the interior of the piston valve, and, in addition, with the high-pressure exhaust whenever this is opened by the valve.

The two annular receivers are in intercommunication through a 2$\frac{3}{16}$in. pipe, thus assuring equality of steam pressure in the two low-pressure cylinders. The volume of each receiver being approximately that of the high-pressure cylinder, their combined volumes are equal therefore to twice that of one high-pressure cylinder—a somewhat low proportion, but in this case the piston speeds are not very high, and the steam is superheated.

With this arrangement no receiver pipes are required. In simple engines with four cylinders there are either four steam pipes, or else forked pipes equivalent thereto; in either case a complicated steam piping arrangement in the smoke-box is involved. Two simple steam pipes suffice, however, with the new valve. The simplicity realised is considerable. Mechanically there is a gain represented by the reduction of four valve motions and valves to two. Not only does this save in the matter of first cost, but obviously there is a saving due to the reduction in the weight and frictional resistance of the moving parts. Again, receiver pipes are done away with, and the parts in the smoke-box are reduced. Thermally, the arrangement steam-jackets part of the valve chest and the interior of the valve itself, the steam pressure that is constantly maintained therein being from one-fourth to one-third of the initial pressure of the first expansion. For example, with saturated steam having an initial pressure of 160 lb. the average back pressure in the small cylinder—say 45 lb., or 293 deg. Fah.—will be the average pressure maintained in the annular receiver and in the interior of the piston valve; and when this valve opens to the low-pressure steam ports the initial cylinder pressure therein will be between 45 lb. and 40 lb., or about 290 deg. Fah. The drop in pressure and tem-

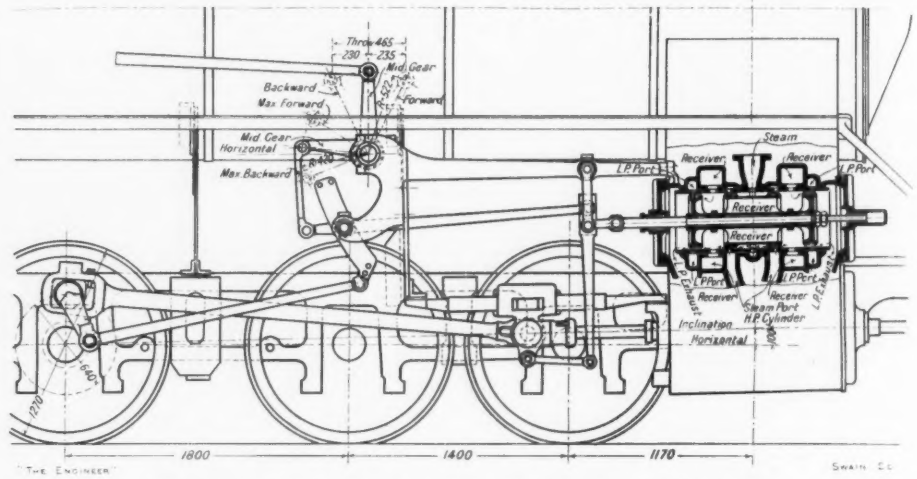


Fig. 1—VALVE AND VALVE GEAR OF MAFFEI COMPOUND GOODS ENGINE

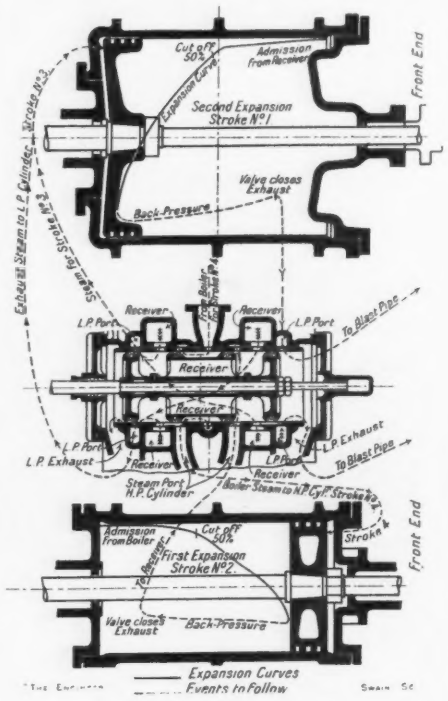


Fig. 2—DISTRIBUTION DIAGRAM

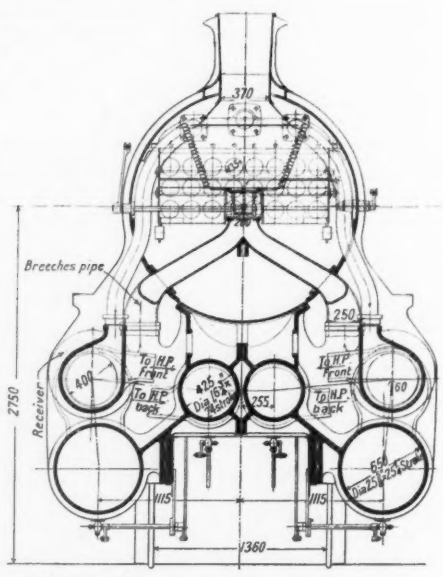


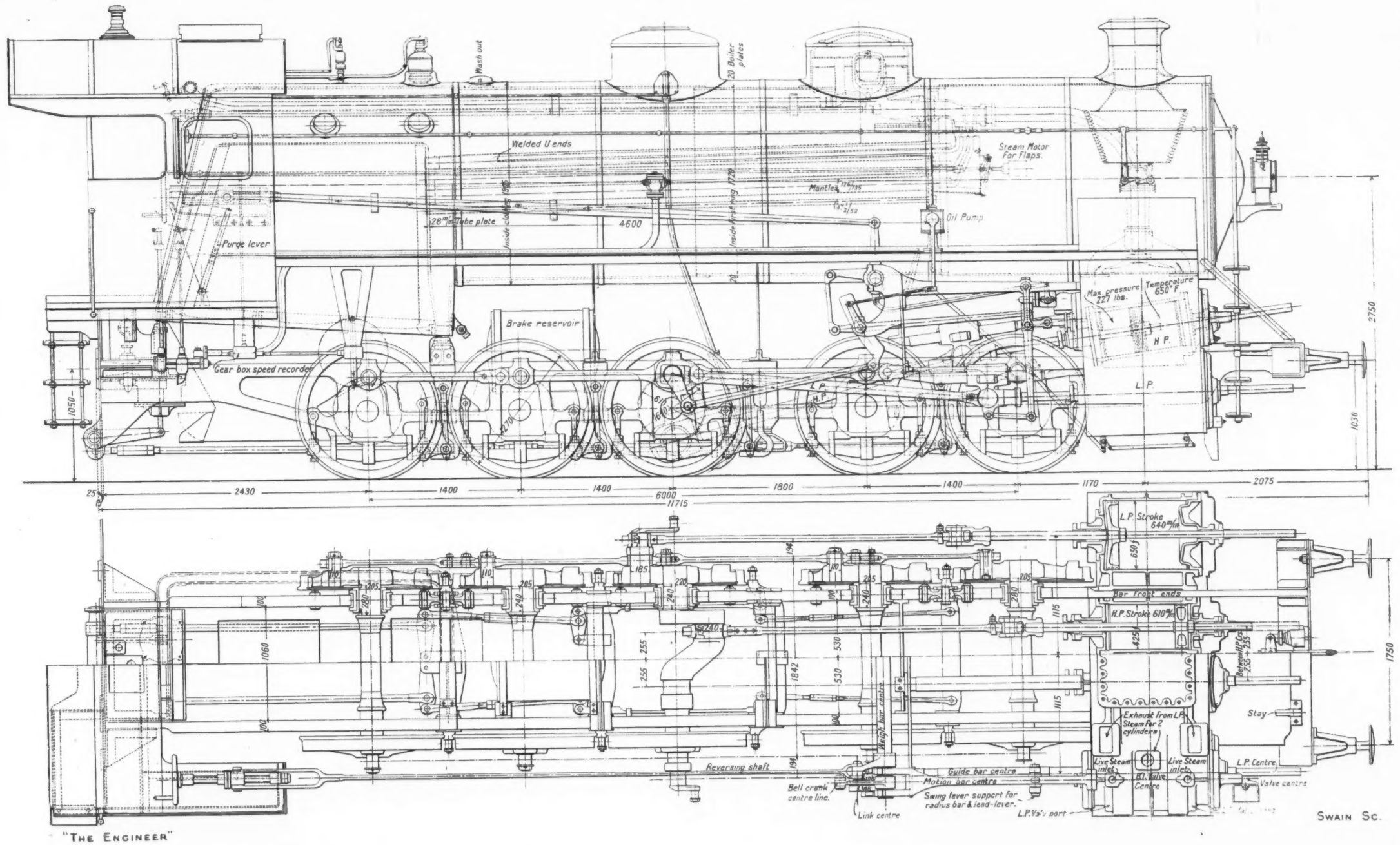
Fig. 3—CROSS SECTION THROUGH CYLINDERS

* No. III. appeared November 17th.

TURIN EXHIBITION—BALANCED COMPOUND GOODS LOCOMOTIVE, BAVARIAN STATE RAILWAYS

J. A. MAFFEI, MUNICH, ENGINEER

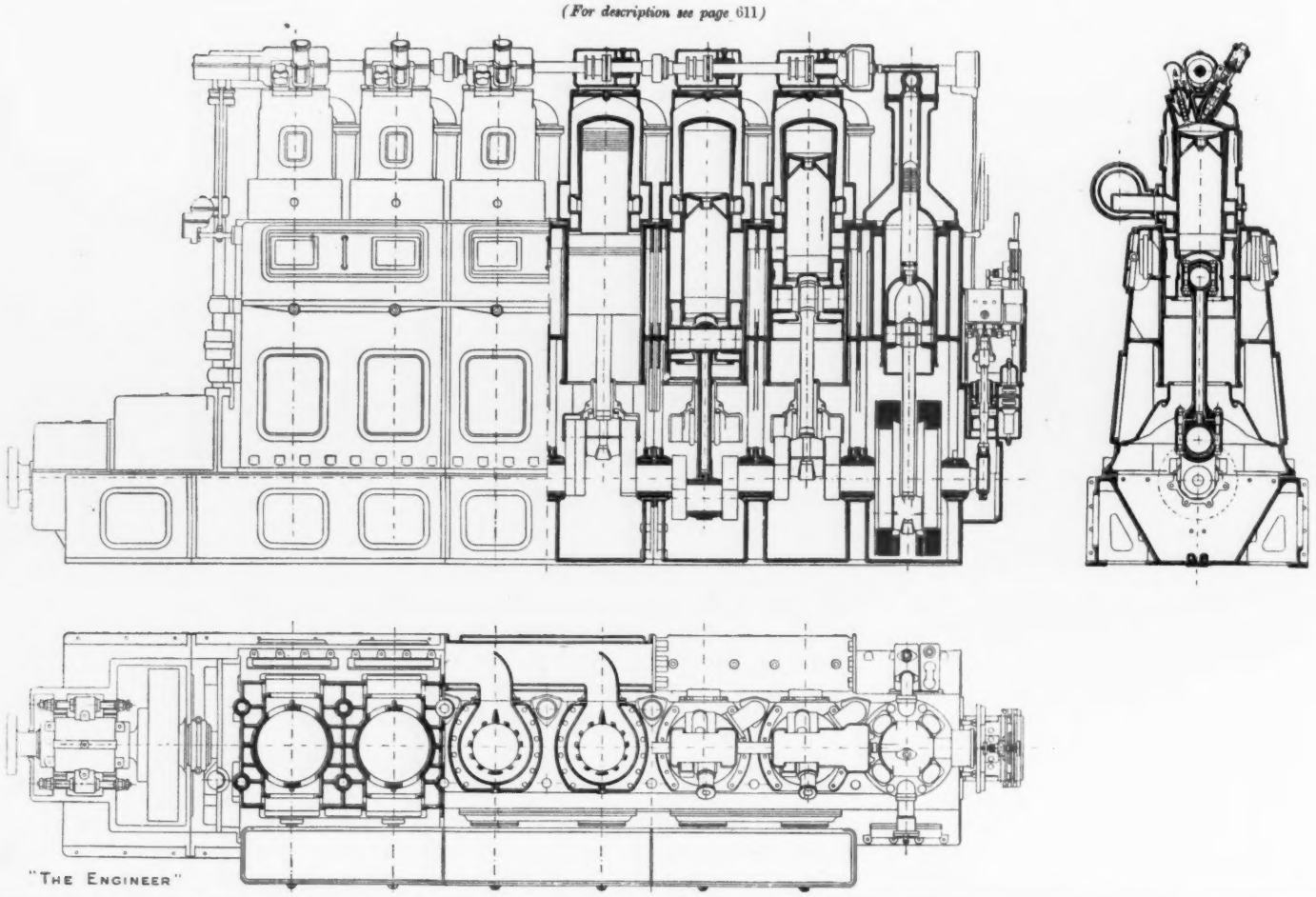
(*For description see page* 608)



SIX-CYLINDER TWO-CYCLE MARINE DIESEL ENGINE

MASCHINENFABRIK AUGSBURG-NÜRNBERG, NÜRNBERG, ENGINEERS

(For description see page 611.)



perature is thus very minute, and a practically continuous expansion is the result. From a fitter's standpoint the single outside valve—there is no valve motion of any sort whatever in between the frames—is said to be found remarkably easy of access for inspection, erection, or taking down.

The engraving—Fig. 1—shows the construction of the valve and gear; whilst the distribution of the steam passing through the valve is shown diagrammatically in Fig. 2. In the latter engraving the valve is represented as being much smaller than the cylinders. In reality the valves are 15¾in. diameter, and the high-pressure cylinders 16½in. Excellent results are said to be obtained by the use of very large piston valves, and there is a general tendency further to increase the dimensions of such valves in common with a radical amplification of the ports and pipes leading to the blast. In Austrian locomotives valves 18½in. diameter are used for 17⅞in. diameter cylinders. The smoke-box cross section—shown Fig. 3—brings out the true proportion of the parts as adopted on the Bavarian Railways.

The back pressure of the final exhaust is reduced by providing a voluminous exhaust pipe at each extremity of the valve chest—see the engraving on page 609. These pipes unite just under the smoke-box, and their common exit is connected to one limb of the internal branched exhaust pipe—see Fig. 3.

Such details as those described above have been proved by numerous experiments in recent years to be of the utmost importance as regards both the efficiency and the speed of the engine. With the progressive increase in the size of boilers all the steamways to, and above all from, the cylinders have undergone a continuous amplification. This is notably so in the case of the valve chests, the steam and exhaust ports, the clearance volumes, the lead to exhaust on the valves, the blast pipes and blast nozzles, &c. The engravings accompanying this article show the ample, short and straight steam outlets typical of modern locomotives. The proportions, as seen from the cross section, Fig. 3, appear quite abnormal relatively to less advanced engine designs. On the other hand, the chimney sectional area is small, this circumstance being necessary with superheated steam in order to maintain an adequate smoke-box vacuum. A protective casing for the hot chimney conceals externally its slender proportions.

The adoption of the balanced compound system for goods engines is quite an innovation in Bavaria, where, until now, they have been built for simple expansion. Following the example of other European railways, the Bavarian State, which has for years employed the compound system exclusively for all its express passenger engines, has not considered the question of steam economy to be so important in goods engines. Indeed, statistics show the gain directly due to double expansion to be less in the course of a year with goods engines than with high-speed engines—and this for various well-known reasons.

The new engines will directly succeed certain simple-expansion engines of the 2–8 wheel type, known as class 4000, and having outside cylinders 21¼in. in diameter by 22in. stroke. To surpass the power of these simple engines without exceeding the gauge limits necessitated the introduction of multiple cylinders; and, given four cylinders, there was nothing to gain, but considerable to lose, from the continuance of simple expansion. Mechanically, no four-cylinder non-compound locomotive yet designed has been made so effectively simple as the compound engine now under notice. It should be noticed, however, that with equal pressures of saturated steam in both the old and new Bavarian goods engines the increase of cylinder power is not so great as would appear to be the case judging merely from the combined volumes of the four cylinders. In the first place, the high-pressure cylinders in the new engines are 28 per cent. less voluminous than the cylinders of the simple engine. Secondly, a deduction of about 25 per cent. from the full power of the smaller cylinders must be made if the second expansion is to develop the same horse-power as the first expansion. With these allowances the effective power of the first expansion of the compound is much less than in the simple engine, as shown by the following statement, in which the unit of volume multiplied by pressure in the simple engine is taken at 100:—

	Simple. Class 4000.	Compound. Class 5800.
Volume × pressure of one cylinder ...	100	72
Back pressure, 5 per cent. simple, 25 per cent. compound	5	18
Effective volume × pressure...	95	54

The full compound expansion is thus: H.P. 54 + L.P. 54 = 108, representing an increase of only $\frac{108 - 95}{108} = 12$ per cent. in power over class 4000. The steam consumption, estimated from the longest running cut-off—50 per cent. simple expansion and 60 per cent. compound expansion—is $0.50 \times 100 = 50$ for the simple and $0.60 \times 72 = 43.2$ for the compound. This shows a difference in favour of the compound of 13 per cent. while developing 12 per cent. more power, or otherwise the compound develops 25 per cent. more power on a given steam consumption.

In the engines of class 5800 the power is further increased by employing a very high steam pressure—227 lb. per square inch. The boiler capacity is increased by superheating the steam to about 650 deg. Cent. and augmenting its volume correspondingly without that increase in fuel consumption which the generation of a like volume of saturated steam would entail. Using this steam, the high-pressure cylinders are made rather larger in volume than would be those designed to develop the same power with saturated steam at the same cut-off. This has decreased the ratio of cylinder volumes to only 1 : 2.45, or the correct proportion for economical results with saturated steam at 174 lb. pressure. It will be observed that the disposition of the cylinders and valves, clear above the frames, allows the greatest freedom in designing the cylinders. Hitherto Bavarian practice has favoured the casting of the group of cylinders in three pieces; in this case there is a return to the American arrangement of two-piece castings bolted together at the middle line of the smoke-box saddle. For the conservation of the heat in the steam the whole design of the cylinders and their short transverse steam connections appears admirable.

Bar frames, milled on both sides, are employed, but the front ends are forged out in the form of slabs. The whole of the machinery of the engine, from the cylinders to the crank axle, is simultaneously visible to anyone standing on the ground under the running boards; even the rods and cranks right out on the opposite side of the engine are partially visible from the same standpoint. This ease of inspection and attendance is particularly remarkable. The exceptional lightness of the frames enables the makers to build powerful engines for light roads which forbid the use of heavy locomotives.

The new goods engines are required to maintain a speed of 15 to 16 miles per hour when ascending gradients of 1 in 100 to 1 in 90 of 30 miles in length with numerous curves, and while drawing a car load of 800 tons, or 928 tons with engine and tender fully loaded. The tractive effort under these circumstances is about 13 tons, and for this an adhesion weight of 77.5 tons maximum is provided. The revolving masses are very nearly perfectly balanced, and this enables the engines to run very smoothly at speeds up to 37 miles per hour with heavier trains on the level sections. To facilitate the taking of curves the first and fifth axles are allowed a certain amount of play in their axle-boxes and side rods, while the third pair of wheels has its flanges turned thinner than the rest. For the even distribution of the weight the first and second and fourth and fifth pairs of axle springs are equalised with balance levers.

The specimen engine exhibited at Turin was noticeable for the severity of its finish, the dull lead colour contrasting with the brilliant colour and varnish of all other locomotives save the Swiss. The effect of this was to divert one's attention from the boiler exclusively to the machinery, of which more was visible to the passer-by than in any other locomotive exhibited.

General Particulars.

Steam temperature	About 650 deg. C.
Test pressure...	16 atmospheres
Cylinders, H.P., diameter	425 mm.
,, ,, stroke	610 mm.
,, L.P., diameter	650 mm.
,, ,, stroke	640 mm.
Driving wheels, diameter	1270 mm.
Heating surfaces—	
Water	206 sq. m.
Steam	47·2 sq. m.
Total	253·2 sq. m.
Grate area	3·7 sq. m.
Weight, empty	69·5 tons
,, fully loaded	77·5 tons
Total wheel base	6·0 m.
Rigid wheel base	3·2 m.
Minimum radius of curves	180·0 m.

Tender.

Capacity, water	22 tons
,, coal	7·5 tons
Weight, empty	21 tons
,, fully loaded	50·8 tons

SOME IMPRESSIONS OF CONTINENTAL MARINE DIESEL ENGINE PRACTICE.

No. II.*

THE Maschinenfabrik Augsburg-Nürnberg, though it has been engaged in the construction of oil engines for some twelve years, only turned its attention to marine reversible engines three years ago, and the extensions it is making to its works and offices give a very good indication of the wonderful manner in which the oil engine is encroaching upon the field hitherto held by the steam engine, and the faith which the firm has in its future. The whole place is an object lesson, which it would be well if some of our builders could see. Of single-acting engines two types are being made—heavy and light.

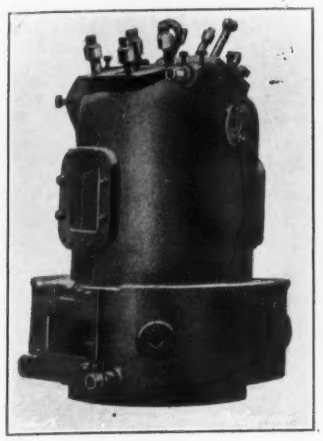


Fig. 1—WORKING CYLINDER

The former are for ordinary commercial purposes, and weigh about 110 lb. per brake horse-power, including all the pumps, coolers, filters, and other auxiliaries and the thrust block. As a standard they are made with six cylinders, and with the even turning movement thus provided a fly-wheel is dispensed with; they are made in eight sizes from 150 up to 2000 brake horse-power, running at from 300 down to 185 revolutions per minute for the two extremes; intermediate sizes not provided for the six-cylinder standards can be obtained by using only four cylinders, when, of course, a fly-wheel has to be used. These engines are specially designed for continuous running, and are cheaper and a little more economical than the light weight engines, which are designed for naval purposes. For the latter the same range of

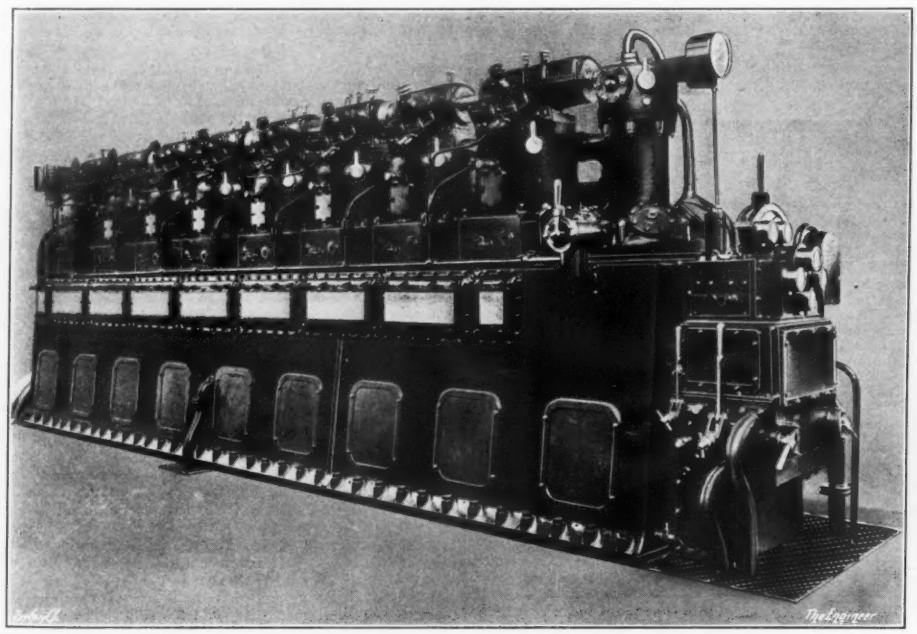


Fig. 2—EIGHT-CYLINDER ENGINE FOR SUBMARINE

powers is covered by ten different sizes running at from 550 revolutions per minute for the smallest to 300 revolutions for the largest. Further sub-division or increase of power can be obtained by making any of these engines with four or eight cylinders. The inclusive total weight of the lighter type is only about 37 lb. per horse-power for larger sizes, and about 50 lb. for smaller sizes. It will thus be seen that the company is able to meet very varied requirements by employing throughout standard engines. The result is a reduction in the cost of manufacture. With both types of engines the speed can be varied down to about 28 per cent. of the maximum.

The engines of the M. A. N. illustrate admirably the simplicity of the two-cycle; in fact, to judge only from a visit to its works, it would appear that the difficulties connected with the two-cycle engine have been entirely over-

* No. I. appeared December 8th.

come, and that the simplicity, with the resultant cheapness, in conjunction with the additional power for a given cylinder diameter, had decided the fate of the four-cycle engine in spite of its superior economy; but we shall deal with this point later. Perhaps the cream of what we were shown was the 850-1000 horse-power double-acting three-cylinder engine for a Woermann Liner giving its power at about 120-140 revolutions per minute, with cylinders 18.9in. diameter by 25.6in. stroke, and weighing about 75 tons. This engine has already made some full load trials, and we were informed that it will shortly be ready for delivery, though it is to remain at the works for some little time in order that the builders may gain some further experience. The scavenging, air, and fuel valves for the top side of the piston are in the cover as usual, the cam shaft being driven by the customary vertical shaft and skew gearing. For the bottom side of the piston there are two fuel and two scavenging valves, one of each on each side, each pair of valves being driven by a separate cam shaft, one of which derives its motion from the vertical shaft already mentioned, while the other has its own short vertical shaft. This arrangement does not present an appearance of great complication, though, of course, it looks a little strange at first sight. The great experience of the M. A. N. Company in the building of big double-acting gas engines has apparently enabled it to overcome any difficulties there may have been with regard to the glands, but we were unable to learn if the absence of the central injection of the fuel on the bottom side of the piston leads to any diminution in efficiency as we should be inclined to suspect might be the case. Arrangements are provided for cutting the oil off the bottom ends of the cylinders, thus converting it into a single-acting engine for slow speeds. The scavenging air is furnished by three separate double-acting pumps on the after end of the crank shaft, while the high-pressure air is obtained from an independent three-cylinder single-acting Diesel engine, also constructed for marine use. Piston-rods and crossheads with flat guides are, of course, necessitated by the design, but it is only in the double-acting engines that they are used. On all the other engines we saw the trunk piston is standard practice. As, however, the working piston is prolonged and enlarged to form the scavenging pump, as shown on page 10, this arrangement is not open to the

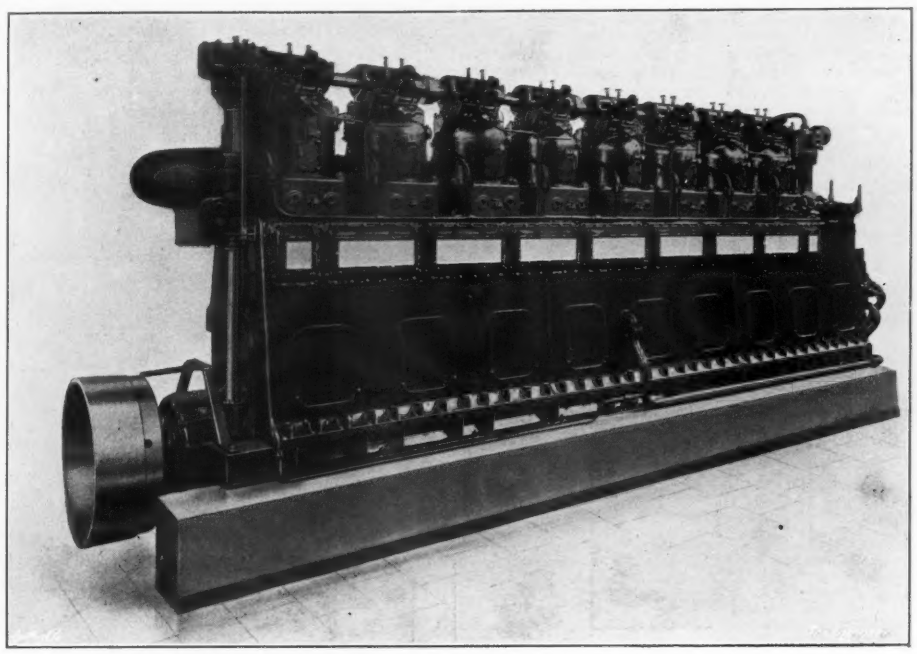


Fig. 3—EIGHT-CYLINDER ENGINE FOR SUBMARINE

extent to the usual objections, as the thrust is largely taken by the latter and the guide is much longer. The arrangement, however, entails a very long piston as shown in Fig. 5, and this makes it impossible to take it out from below; the main or working cylinder, Fig. 1, has, therefore, to be lifted off the frame, leaving the scavenging cylinder as shown in Fig. 4. The connecting-rod, cam shaft, &c., have to be disconnected and the piston withdrawn upwards, entailing a good deal of dismantling. We must refrain, however, from passing our usual strictures on the plan, as it must be remembered that it permits of a very considerable simplification as compared with other engines. By forming the scavenging piston in one with the main piston, there is a merely trifling increase in height, but a very great saving in length as compared with the usual arrangement of separate scavenging pumps, with their own cranks and connecting-rods. There is thus the great saving in cost, weight, and length to put against the greater difficulty of dismantling. The arrangement is so good that it seems to us that it would be well worth a little scheming in the endeavour to obtain this advantage too, though we are unable at the moment to make any practical suggestion in this direction. Forced lubri-

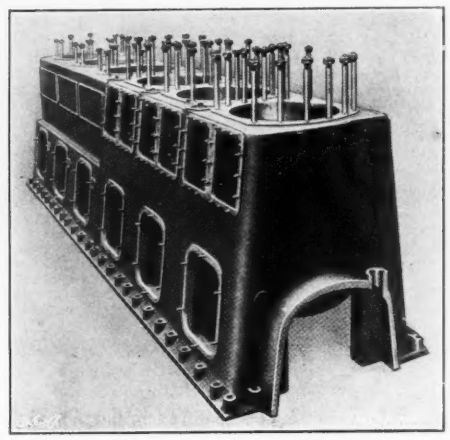


Fig. 4—FRAME AND SCAVENGING CYLINDERS

cation is employed, and in consequence the whole of the front of the engine is enclosed by wrought iron plates between the columns. The fuel pumps are situated in a group at the after end, where also is the manœuvring gear, which will be dealt with later on.

A very interesting comparison was provided by the fact that close alongside of the double-acting engines was a pair of six-cylinder single-acting engines, Fig. 8, each giving 900 brake horse-power at 260 revolutions per minute, and looking ridiculously small considering that the power was approximately the same as in the engine just described. It was here again that the simplicity of the two-cycle engine enforced itself. A single cam shaft runs right along the top of the cylinders, driven, as before,

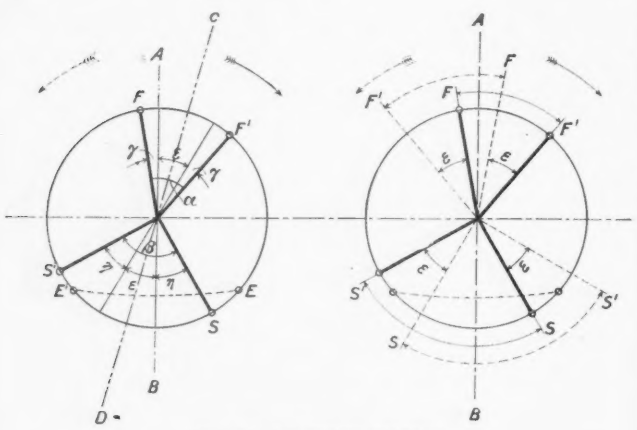
off a vertical shaft, but each cylinder has only four cams, one for scavenging air, one for the fuel valve, and two for the compressed-air starting valves; one of the latter cams being for ahead and the other for astern, all being cased in. The scavenging air is provided, as mentioned above, by the enlargement of the lower end of the main piston of each cylinder, and the high-pressure air by a pair of compressors at the forward end of the shaft, which are in duplicate for the sake of balance, while the six fuel pumps are grouped together at the after end. The scavenging air suction valves are simply rectangular steel plates held in position on a grid by a light spring at each corner. The pistons are all oil cooled, the oil flowing back into the crank case, where it falls into a tank at the after end whence it is drawn by a special pump, and passed through filters and coolers, and distributed back through the system. We noticed that a substantial shield is fitted over the crank webs to prevent an excess supply reaching the scavenging cylinders. The gudgeon pins share in the forced lubrication through hollow rods.

We were particularly interested in the light type of

Fig. 5—PISTON

engine, of which we saw quite a number under construction, for submarines. Here the bed-plate and cylinder frame are made of manganese bronze, which, with the higher speed, accounts for the reduction in weight per horse-power, and, with a stroke-bore ratio of 1.2, results in a very neat and compact-looking engine. One of these —Figs. 2 and 3—we were able to see running on the test bench, and as the details are similar to those of the engines described above, we may now explain the method of reversing which we here saw carried out.

It will perhaps facilitate the description of the mechanical operations if we first put our readers in mind of the various valve openings and closings which require to be manipulated before an engine of this type can be reversed. The exhaust is, of course, governed both as to its opening and closing by the passage of the piston itself over ports in the cylinder walls, the crank position at the moment of opening being represented by the point E in Fig. 6 for an engine running in the direction indicated by the full-line arrow. The port opening extends round to the point E^1, and is equal on each side of the centre line A B,



Figs. 6 and 7—VALVE DIAGRAM

that is, it is correct for either direction, and so need not be further considered. There remain then the fuel and scavenging air valves. The crank position at the moment of opening of the former is represented by F—Fig. 6—the opening extending round to F^1, while $S S^1$ are the corresponding positions in connection with the scavenging air valve. The diagram shows that each of these valves has a certain "lead angle" of opening, represented in the case of the fuel valve by γ, and in the case of the scavenging air valve by η, and it will be realised that before the engine is in a condition to run in the reverse direction it will be necessary to reverse these "lead angles" and place them on the opposite side of the centre line A B. Even though these "lead angles" and also the duration of opening are of quite different magnitudes in these two valves, this reversal is effected in the following ingenious manner by a simple dog-clutch coupling on the vertical driving shaft, which has a certain amount of play—in this case 30 deg.—between the driving and the driven face. It will be seen from the diagram—Fig. 6—that the total angle of opening α of the fuel valve is made up of twice the "lead angle" γ plus an angle ϵ, while the total angle of opening β of the scavenging valve is made up of twice the "lead angle" η plus an angles, so that we have the latter angle ϵ common to both. It will further be seen that if this angle ϵ is bisected by the line C D, the angles α and β, and equally the angles ϵ, lie symmetrically about C D. Provided then that the fuel and scavenging valve cams are arranged symmetrically about the line C D, with the length of the nose of each suitable to the respective periods of opening F F_1 and S S_1, it follows that the actual alteration of the position of the cam shaft in relation to that of the crank shaft necessary to place both valves in the proper relationship to the latter to give reversal can be obtained by a single movement of the cam shaft through the angle ϵ. The diagram—Fig. 7—shows in full lines for ahead, and in dotted lines for astern, the respective openings of the two valves when varied by the movement of the cam shaft through this angle ϵ.

We can now perhaps best make the process clear by referring to the late Mr. F. W. Webb's practice in some of his compound engines, where the two high-pressure cylinders had Joy valve gear, while the low-pressure cylinder had a single loose excentric. The engine was started in the required direction by the setting of the high-pressure valve gears and the admission of steam. This caused the shaft to rotate through a small angle, when the key caught up the eccentric, and the low-pressure cylinder would then take up the steam admission for the altered direction. In the case of the motor, the part of the high-pressure cylinders to start the engine in the right direction is taken by those cylinders of which the cranks are in the correct position for driving in that direction. For instance, if the engine is required to run in the direction of the arrow in Fig. 9 air only is admitted to Nos. 2 and 3, which start the engine in that direction, and so carry the driving face of the coupling through the slack up to the driving face on the cam shaft coupling for that direction. To provide port openings, however, of such dimensions as to place the starting by compressed air of a six-cylinder motor absolutely beyond doubt, the variation of 30 deg. between ahead and astern provided for the fuel and scavenging air valves would not be sufficient, and different arrangements have to be made. As has already been mentioned, two compressed air starting valves are fitted in each cylinder head, and each of these valves has its own cam so designed as to give an air opening of sufficient length to ensure starting in whatever position the cranks may have stopped. The proper cam for the required direction is brought into action by the interposition of a small disc between the cam and the valve, which is operated by compressed air. This movement of the engagement of the disc, which is the only one necessary for reversal, is performed by a single little lever, and is as simple as, and somewhat similar in operation to that on the Houston and Gall engine described in THE ENGINEER, May 19th last. Thus there is no lifting the cam rollers off the cams, and no shifting of cams or shafts, and the whole arrangement is simplicity itself. The 360 horse-power engine with four cylinders, which we saw running, was stopped, started, and reversed as rapidly, as simply and as certainly as could be desired by this one little lever, so that there could be no mistake in making a wrong sequence of movemements, while the simplicity as compared with the

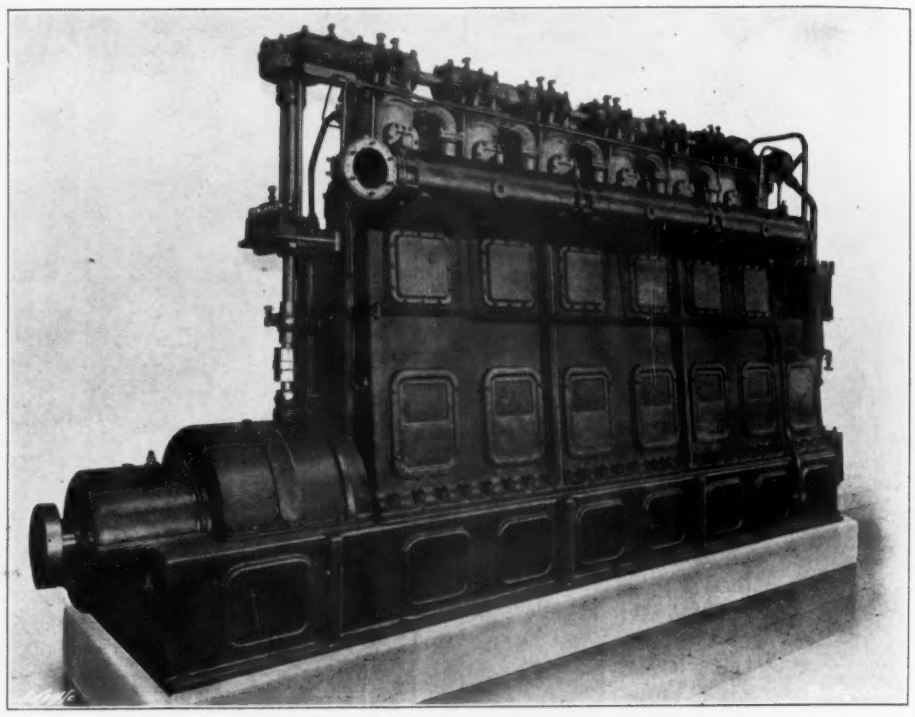


Fig. 8—900 H.P. SIX-CYLINDER SINGLE-ACTING ENGINE

Fig. 9

two cam shafts or the shifting cams should be seen to be appreciated.

THE CUNARD LINER LACONIA.

LAST Saturday evening, 9th December, the new twin-screw Cunard liner Laconia successfully completed her trial trip near the mouth of the river Tyne. At nightfall the vessel anchored off the pier head, and the following morning proceeded on her voyage to Liverpool, going round the North of Scotland. She was due to arrive in the Mersey on Tuesday morning, 12th inst., to make final preparations for her maiden voyage next month.

The Cunard Steamship Company now owns nine ships built by Swan, Hunter and Wigham Richardson, Limited, of Wallsend-on-Tyne. Of course, the best known of these is the famous Mauretania, and the other vessels are the Franconia, Laconia, Ivernia, Ascania, Ausonia, Carpathia, Ultonia, and Albania. Next to the Mauretania, the Laconia and her sister ship the Franconia are the two largest ships that have ever been constructed on the river Tyne. The leading dimensions of the Laconia are 625ft. in length, 72ft. broad. Her gross tonnage is about 19,000, and her displacement 25,000 tons. The main engines have been built by the Wallsend Slipway and Engineering Company. They consist of two sets of four-crank quadruple-expansion engines dynamically balanced on the Yarrow, Schlick and Tweedy system, steam being supplied by six large double-ended boilers.

The Laconia will eventually run in the Liverpool-Boston service, though in the winter she will be employed in the Cunard cruises from New York to various Mediterranean ports. To add to the comfort of passengers by increasing the steadiness of the ship, Frahm's anti-rolling tanks have been installed. It is interesting to note by way of illustrating the Cunard Company's desire always to keep abreast of the times and to make its ships second to none, the Laconia is the first British ship and the first North Atlantic liner to be fitted with these tanks.

In internal arrangements the Laconia is as comfortable as anyone can desire. The cabins as well as the public rooms are lofty, spacious, well ventilated and heated. The second-class accommodation has been carefully planned, and is in every way equal to what was provided for first-class passengers only a few years ago. The third-class passengers have also been well cared for. Airy cabins are provided, together with dining rooms, social hall and smoke rooms.

MODEL OF COAL-SCREENING AND WASHING PLANT.—The British Humboldt Engineering Company, Limited, of Dixon House, Lloyd's-avenue, E.C., is at the present time exhibiting at the Science Museum, South Kensington, London, the model of a coal-screening and washing plant built by the Humboldt Engineering Works Company, of Cologne-Kalk, at Pit 5 of the Rheinpreussen Collieries, Westphalia. This plant is built in two units of a combined capacity of 200 tons per hour. The model at the Kensington Museum is an exact reproduction of the actual works, showing both the screening and washing plant, railway tracks, coal towers, &c., and all of the special appliances made use of, as, for instance, Humboldt jigs, double-crank screens, long fine coal-draining belts, distributing tables, for the coking of coal, &c. A part of the roof and side walls of the model are left out so that the inner equipment of the plant can be readily inspected. The buildings consist of skeleton steel work, while the platforms are partly of concrete and partly of chequered steel plates. The roof is constructed on the "Monier" system.

RAILWAY MATTERS.

A FRENCH company has laid before the Municipality of Rome, which, it is said, is in favour of the project, proposals to construct an electrical railway from Porta San Paolo to Ostia, with its line underground between the terminus in Piazza Venezia and the Palatine Hill, and with a sunk cutting to Porta San Paolo. The cutting beyond the Palatine Hill will traverse a greater portion of the Zona Monumentale, that contains many relics of ancient Rome hitherto unexplored, and representations are made by Commandatore Boni against the probable destruction of antiquities involved by the scheme as planned at present.

THERE are 30,000 men employed on the Ichang-Wanhsien Railway, China, and construction trains are working out of Ichang, on the Yangtse-Kiang River, for several miles. One tunnel 1000ft. long has been bored, and another 6000ft. long is under way. The earth work is well up to Kweichow, a distance of 100 miles. At Ichang machine shops and station buildings have been erected. The line runs inland from Ichang and comes out at the Yangtse-Kiang River near Hsiang Chi, about 90 miles distant. It then follows the river for about 30 miles, when it will again go inland along a route which has not yet been definitely determined upon.

THE London and North-Western Railway made a fine run the other day from Euston to Glasgow. According to the *Railway News*, the train was ordered by a cinematograph firm whose representative lost the Scotch express at Euston. A special train was chartered and consisted of three loaded vehicles. It left Euston at 1.29 a.m., passed Rugby at 2.54 a.m., and arrived at Crewe at 4.8 a.m.; departing at 4.14 a.m. it passed Preston at 5.8 a.m., and arrived at Carlisle at 6.45 a.m. The train was worked by a "Precursor" type of engine, No. 2115, Servia, between Euston and Crewe, and by a 6ft. 6in. "Precedent" class of engine, No. 1515, Milton, from Crewe to Carlisle.

IT is reported in the *Electrician* that a new automatic starting device for lifts, which takes the place of the ordinary controller, has just been put into operation at Piccadilly-circus Tube Station. It is the first of its kind that has been tried in London, and its operation is said to be satisfactory. The action of closing the lift gate operates the starter and the lift begins to move. This reduces any waiting for the controller key to be inserted. At a station like Piccadilly-circus, where there are eight lifts, a time-saving device of this kind will, it is claimed, enable three additional lift trips per hour to be run. Other lifts on the system will shortly be fitted with this device, and the first stations to be so equipped will be Highgate and Oxford-circus.

THE Pennsylvania Railway has received a simple superheater Mallet locomotive, which is being thoroughly tested from the American Locomotive Company. The design is an attempt to get the most powerful locomotive possible, consistent with the rather narrow overall cross-section, which has made necessary the use of simple cylinders. An interesting feature, which will develop in time, will be to see how the simple type Mallet with a superheater will compare with the compound type with and without a superheater. The engine has 27in. by 28in. cylinders, 4ft. 8in. drivers, and carries a boiler pressure of 160 lb. It has a tractive effort of 93,000 lb., and a total weight of 483,000 lb. Of this 23,500 lb. is on the leading truck, 435,500 lb. on the drivers, and 24,000 lb. on the trailing truck. The tender weighs 186,400 lb.

IN an article on the railways of Brazil, a contemporary tells how the Government of Brazil builds lines in accordance with public demand, and then leases them out either to the construction company or to some other concern to be operated. A great deal of difficulty arises when the operating company and the construction company are not the same, for in such cases the construction company exercises such stringent economy in its work that the operating company is greatly handicapped. Even the Government, which pays for the work, is sometimes persuaded not to demand certain work which is really necessary. To this is due the large number of excessively sharp curves, the bad spacing of ties, the extremely light rails, &c., faults which are dearly paid for by the operating company in fuel or in abnormal maintenance of way expenses.

ACCORDING to the *Railway News*, the Russian Government has now authorised the construction of six private railways, with a total length of 1160 miles, involving an expenditure of about £11,300,000. To this should be added several branch lines, for the construction and working of which independent companies have not been formed, thus bringing the total length up to 1230 miles. For the purposes of comparison it may be stated that previous concessions for private railways were granted as follows:—1905, 15 miles; 1906, 100 miles; 1907, 185 miles; 1908, 1326 miles; 1909, 300 miles; 1910, 290 miles. The high figures for 1908 are explained to some extent by the North Donetz Railway concession, this one line being 563 miles long. Although it is not expected that any further concessions will be granted in the near future, it is known that a good many projects are being prepared for new private railways.

IT is reported in the *Railway Gazette* that Germany's new West African territory is to be linked up with its East African colony by a service of motor cars across the continent, passing through the Belgian Congo. The connection of different districts by a service of motor cars has already been tried with encouraging success in the Belgian Congo, and the German Government has decided to adopt the same means of communication. New roads will have to be cut through forest and hewn out of mountainous country; bridges will have to be constructed to span rivers, and a considerable amount of organisation will be necessary before the scheme gets into working order; but already a number of German engineers and military officers are surveying the ground and studying the best route. The new territory referred to is, of course, that just ceded by France to Germany in settlement of the Morocco dispute.

THERE is a proposal to the effect that the County Council of Lanarkshire should acquire all the tramways within its area and operate them in the public interest. There are lines joining up Motherwell, Hamilton, Wishaw, and other industrial centres in the county, and it is possible for a traveller to pass through all these towns to one of the termini of the Glasgow Corporation system, then over the Glasgow lines to Dalmuir and, by changing to the Dumbartonshire system, to Loch Lomond. The municipal authorities in the Lanarkshire towns have had a conference on the question whether public action should be taken regarding the lines within their areas, and they have asked for a meeting with the county council in order to discuss the subject. The council has also been asked to take steps for the acquisition of the gasworks within its district, but so far nothing definite has been done in this direction.

IN commenting upon Mr. Philip Dawson's paper read at the Royal Automobile Club on Friday, December 8th, the *Railway News* remarks that the principal reason for the choice of the continuous-current system by the London and North-Western Railway is not far to seek, if we consider the fact that it is proposed to run a large number of North-Western trains both over the Metropolitan District Railway and the Bakerloo Tube. Furthermore, as far as the actual lines of the North-Western Railway to be electrified are concerned, they constitute a practically separate system, and their electrification would in no way interfere with the adoption of another system should the North-Western Railway directors consider the electrification, say, from London to Birmingham, or of any other part of their system, which would not have to work for considerable distances over railways already equipped with continuous current.

NOTES AND MEMORANDA.

ACCORDING to *Eastern Engineering*, up to now the manufacture of wood pulp for paper making has not been introduced into Eastern Siberia, but there are very large supplies of spruce and fir along the sea coast which could be utilisable for this purpose, being, on account of the climatic conditions, unsuited for cutting as timber. Water-power is obtainable nearly everywhere along the coast from the streams flowing down from the Sikhota-Allin mountain range. On the other hand, these streams are very frequently inaccessible for industrial purposes on account of the scarcity of harbours. Aspen can be obtained in large quantities for from 4½d. to 5½d. per cubic foot alongside vessels at Vladivostok.

ARTIFICIAL limestone blocks for the new reinforced concrete hospital at Coney Island, New York, were made at the contractor's plant near by and taken to the site in cars. In the manufacture of the stone, clear white pine patterns were first made to correspond in detail to the full-size drawings. These patterns were then impressed in a wet sand mould and, when removed, a matrix of grout was poured. This grout consisted of one part Portland cement to two parts of aggregate, consisting of one part of marble dust and the remainder limestone, graded from ⅛in. to ¼in. The stones were left for four days, then were hoisted from the moulds and cured in the open air, covered by a layer of canvas, which was kept well wet. They were then cleaned and finally finished on a rubbing bed. All the walls are of interlocking hollow-tile blocks.

THE jointing of enamel wire, as used for electrical purposes, demands special treatment. The joint should be silver soldered, brazed, or electrically welded. Ordinary solder would not do, as it would not stand the heat required to harden the enamel. After soldering, the enamelling solution is thickly applied to the joint. The enamel has then to be hardened. A special stove is supplied for this purpose. It consists essentially of a tube split in two halves; these are clamped over the joint, the wire resting on small mica bridges provided inside the tube. Heat is then applied from any available source, such as a Bunsen burner, blow lamp, or Swedish torch. The heat should be applied for about 3 mins., and the joint allowed to cool before handling. The temperature required for fixing the enamel is about 600 deg. Fah. The process can be repeated for two or three coatings.

ADDRESSING the Electric Club of Chicago, Mr. C. G. Osborne, metallurgical engineer of the Illinois Steel Company, enumerated four methods of making steel, the Bessemer, open-hearth, crucible, and electric furnace processes. The last, he said, was destined to be one of the most important of all, owing to its convenience in applying great heat. The United States Steel Corporation had, he added, three electric furnaces in its works, one at Homestead, one at Worcester, and one at South Chicago. Three large electrodes were used in each, and alternating current was used at a terminal electro-motive force of 55 volts or less, with a frequency of 25. From the steel makers' point of view 40 arcs would be better than three, as they would afford a more uniform temperature. Steel made by the electric furnace process was said by some to be better than other steels. The economy of production was about that of the crucible process in the comparatively small quantities as now made, but would probably be reduced to that of the open-hearth process if used extensively.

TWO lectures were recently delivered at the Manchester University by Mr. E. W. Smith on the subject of "High-pressure Gas." Mr. Smith gave his hearers the benefit of his experiments in high-pressure gas laboratories at Birmingham. His view is that "the future for gas is in its further applications for heating." Mr. Smith said he believed there was no limit to the field of gaseous heating. The chief essentials were cheap gas and a constant calorific value. Gas furnaces used were formerly only under special circumstances necessitated by the work. Consequently the question of efficiencies had less attention than they had now-a-days, when the public were realising that much of the smoke nuisance could be abolished, and gas men were realising that gas could be made economically to compete with other fuels in many other heating processes which had not yet been touched. The future for gas was in its further applications for heating. However successful the lighting was and became, from the point of view of consumption, heating and power would be the mainstay of the industry.

A SOMEWHAT curious system of underground transport used in a mine at Von de Heydt, in the Saar district, is referred to in *Electrical Engineering*. Electric accumulator locomotives are employed, with an automatic controlling arrangement, instead of a driver. The locomotives are small in size, and are under 2½ tons in weight, and draw from 10 to 16 tubs. The locomotive has a long projecting bow-shaped buffer, which, when it meets an obstacle, is pushed in and thereby puts the controller through the off position into the braking position, stopping the train before the buffer has reached its innermost position. As soon as the obstruction is removed the buffer is pushed out again by its springs, and the locomotive starts again. The speed does not exceed about 2½ miles per hour. Special arrangements are provided for opening ventilation doors automatically before the locomotive reaches them, and an automatic gate is employed at junctions, which is locked by the pressure of a train fouling the junction, and released as soon as it has passed, permitting the branch train to proceed and follow the train from the main line.

IN order to avoid visible fluctuations in the light of glow-lamps on alternating current, the frequency should not be less than 50. Inconvenient variations would occur on a traction circuit, where the frequency may be as low as 15. The author of an article which recently appeared in the columns of a French contemporary suggests a special device to avoid this. Two lamps may be employed in the same globe (preferably provided with a frosted or other diffusing surface), one lamp being fed direct from the supply, and the other having a condenser or inductive resistance in series. With a difference of phase of 90 degrees, the respective maxima and minima in the light from these lamps occur simultaneously so that the variations in the light are reduced. It may also be desirable to introduce an equivalent non-inductive resistance in the other circuit, so that both lamps receive approximately the same current and give the same light. Another method is to put an inductive resistance in series with one lamp and a condenser in circuit with the other. The system can also be varied by having inthe same lamp two distinct filaments fed from the main circuit in the manner described.

AT a recent meeting of the Birmingham and Midland Institute Scientific Society, Mr. C. A. Line gave a lecture on the dangers of lead poisoning and its prevention. The lecturer's remarks applied principally to lead poisoning in the painting trades, and he sought to impress upon the public the grave moral responsibility resting upon them in combating this "terrible racial poison." He pleaded for a refusal on the part of the public to allow house painters to use white or red lead in their work. Since the last return was issued, he said, there had been a gratifying decrease in the dangers to which potters were subject, but not so among painters. Not only were but very few of the cases in the painting trades ever reported, but the number of deaths in proportion to the causes of illness among painters was the highest on record amongst all the dangerous trades. The causes of poisoning in their order of importance appeared to be—(A) dust caused in sandpapering the surface of paint; (B) dust from mixing white lead with oil; (C) dust arising from paint that had dried on the overalls used by the workmen; (D) absorption of lead by the mouth from unwashed hands; and possibly (E) fumes from burning off paint.

MISCELLANEA.

ACCORDING to the *Electrical Review* it is proposed to call together a congress of Spanish electricians, with a view to considering the means for stimulating the development of electricity and its various applications throughout Spain.

IT is suggested that where long electric transmission lines cross desert regions, as in some parts of California, for instance, arrangements may be made to provide electric beacons or lamps at dangerous road crossings where travellers are apt to get off the beaten line of travel at night.

DURING the ten months ending October 31st Great Britain exported iron and steel and manufactures thereof to the value of nearly 36 millions; other metals, 9 millions; cutlery, hardware, &c., 6 millions; electrical goods, over 2½ millions; machinery, 25½ millions; and ships, 4½ millions. The aggregate of the increases among these items was approximately 2½ millions.

AT a meeting of the Executive Committee the Farmers' Union resolved to ask the Postmaster-General to reconsider the scheme for rural party telephone lines and to arrange for farmers to be connected with the main telephone line at a much cheaper rate than at present. Mr. Colin Campbell (chairman) said that farmers wanted private telephones and not party lines. Mr. Sayce, of Liverpool, remarked that want of confidence among farmers had not altogether disappeared, and as conversation on the party lines could be overheard it would be almost impossible for the bells to ring without all the subscribers going to hear what was said.

AT a meeting of the Cleveland Institution of Engineers, held at Middlesbrough, Mr. Antony Ablett, of London, read a paper on "Some Modern Developments in the Electrical Driving of Rolling Mills." The system, he said, was being more extensively adopted every year. The opinion had been expressed in some quarters that electrical driving did not pay for sheet mills, but this was quite contrary to the general experience of electrical driving—namely, that where the power required was most variable, electrical driving proved the most economical. As sheet mills required such a great variation in power, they should offer the most promising field for effecting economies by electrical driving.

THE Royal Commission on Metalliferous Mines and Quarries recently occupied the whole of a sitting in taking the evidence of officials from the Cornish tin mines. There appeared to be a consensus of opinion that the injurious effects of the dust upon the miners engaged in rock drilling could be largely obviated if the men themselves took reasonable precautions. The use of the hammer type rock drill with water passed through a hollow steel bit was generally advocated, together with respirators. The use of a simple piece of sponge seemed to be the favourite form of respirator. The witnesses were practically unanimously in favour of a strict Government supervision of explosives. The general use of electrical firing of blasts was unanimously deprecated. Several witnesses advocated the use of acetylene lamps in preference to candles because of the increased lighting power obtained.

THE American Consul at Cardiff, writing on the tin-plate industry, states that the march of progress which has held the attention of the industrial world since 1900 was continued during 1910. Exports from the United Kingdom reached nearly 500,000 tons. This record, he says, surpasses that of 1891, known in Wales as "the tariff boom year," when, to escape the duty fixed by the increased American tariff, exports leaped to 450,000 tons. The loss of the American market brought a decline each year until the beginning of the present century. New markets were industriously sought, new uses for tin-plates were found, and during this first decade of the twentieth century the Welsh tin-plate industry has enjoyed a period of prosperity which is said to be unknown in the history of any other manufacture. Thus this industry, after the sudden loss of its greatest market, has recovered itself entirely.

THE British Vice-Consul in Bulgaria in his latest report remarks upon the apathy of the British trader so far as Bulgaria is concerned, attributing it to the comparative smallness of this market. Bulgaria, however, takes a proportionately larger share of foreign manufactured goods than many countries of greater size. The material for Government contracts, for instance, is supplied almost entirely from abroad, and important orders for railway material, harbour plant, electric lighting, and other municipal undertakings are continually being placed with continental firms. The demand for manufactured articles of every kind is steadily growing with the economic and social development of the population, and the moment seems propitious for the adoption of new methods and the retrieving of some errors of the past. It is going over well-trodden ground to say that the lack of commercial travellers, severe insistence on cash payments, defective trade catalogues, and the non-existence of a British bank are the chief causes of our failure to keep pace with our foreign rivals; but as our shortcomings in these respects are as evident to-day as they have been in the past, the Vice-Consul reminds us of them once again.

A NEW system of towing will be employed in taking vessels through the Panama Canal, according to specifications shortly to be issued by the American Government calling for 40 electric locomotives to be used on the work. It is intended to utilise the locomotives for taking the vessels through the locks at the rate of two miles an hour. The vessel to be towed will be held between four lines of taut hawsers. The hawsers are to be attached to the windlasses of four locomotives operating on the lock walls, two forward towing and two aft being towed by their hawsers, thus holding the ship steady. The locomotives are run on a level, except where they pass from one lock to another, at which point they will climb exceptionally heavy grades. There will be two sets of tracks along the lock walls, one for the return of unattached towing engines. The tracks will be of the 5ft. Panama Canal gauge laid on 90 lb. Bessemer rails on Carnegie steel ties. Each locomotive will consist of three parts, two tractors with a windlass between them. The windlass will be mounted on a truck and joined to each tractor by a drawbar and trunnion, having the effect of a universal joint. The windlass will have two speeds, one for coiling the line under a load and another for coiling an unattached line.

IN a letter to *Nature* Sir Oliver Lodge gives a note of warning with regard to attaching too much importance to negative results obtained by supposed electrification of a wire network over a field, "unless there is reasonable guarantee that such network was really kept positively electrified during considerable periods. It has been attempted in the past," he points out, "and it is still tempting, to supply electricity to a network by means of elevated spikes, arranged so as to utilise the gradient of potential naturally existing in the atmosphere. But think," he adds, "what singularly perfect insulation would be required to enable electricity slowly supplied in this way to accumulate until a fizzing point was reached. The attainment of such potential over a large area would in this climate be quite impracticable except when a thunder cloud was passing overhead. The same difficulty of adequate insulation must," Sir Oliver thinks, "have militated against many attempts made in the past to supply electricity from artificial but old-fashioned high-potential sources, especially when the area to be supplied extended over many acres. It must be further remembered," he says, "that any metallic network not really charged, but kept practically at zero potential by leakage to earth, would be presumably detrimental to the growth of plants beneath it; inasmuch as it would tend to screen them from the natural inductive electrification to which they are entitled."

BRIDGE OVER THE KUSKULANA RIVER, ALASKA

(For description see page 607)

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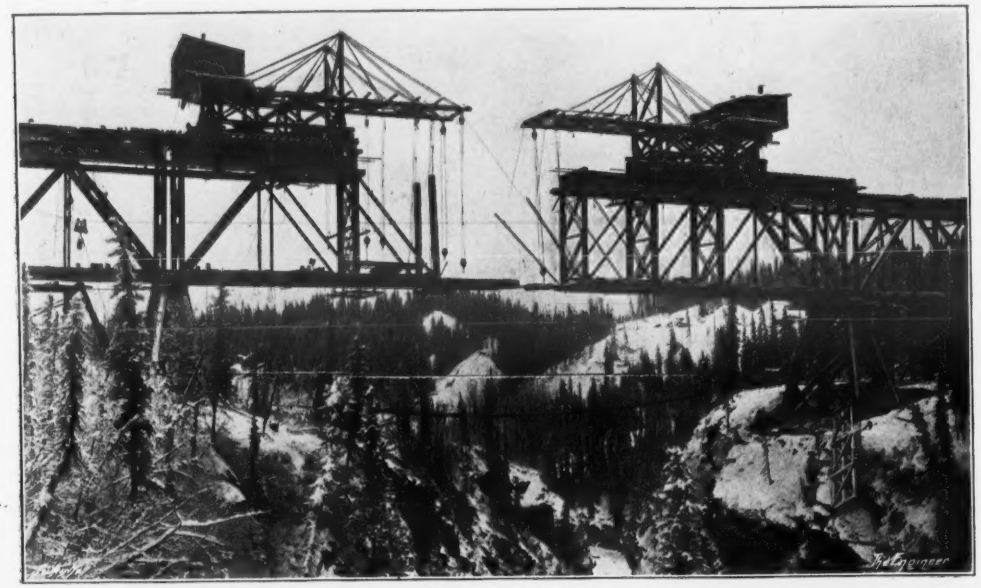

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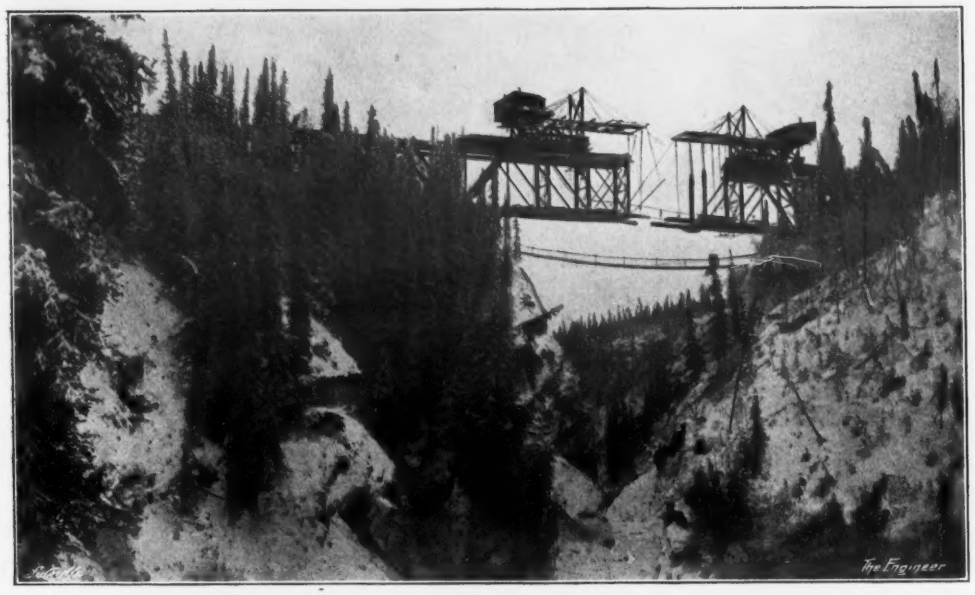

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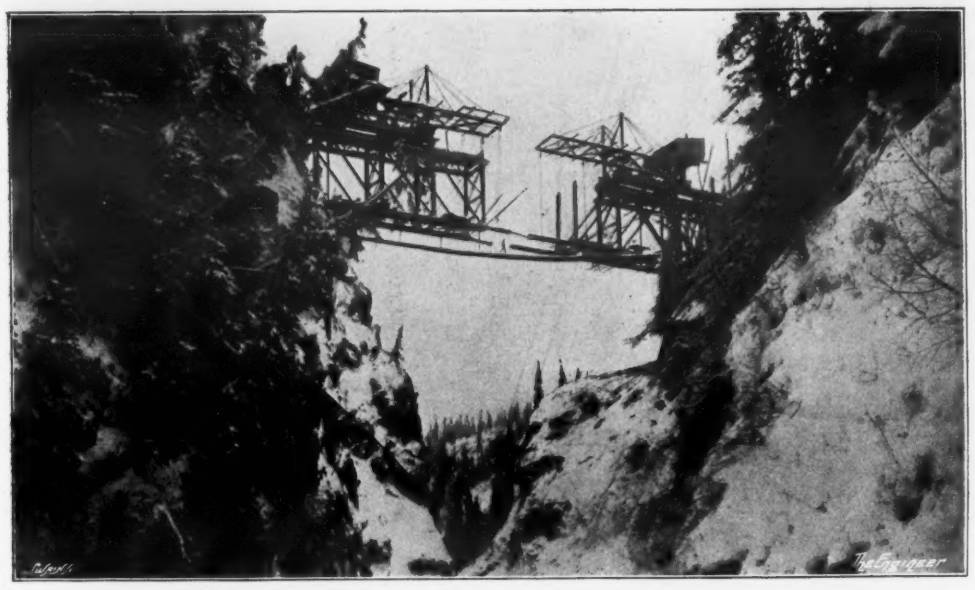

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MEETINGS NEXT WEEK.

(*See "Forthcoming Engagements" page* 624.)

THE ENGINEER.

DECEMBER 15, 1911.

The Railway Settlement.

ANOTHER agreement has been signed by the Board of Trade, the Railway Companies, and the Trades Unions, and peace is believed to be once more restored. Bitter experience has taught us to regard all such agreements with suspicion, and we shall withhold our opinion of the value of the present bond until it has been proved. As it stands we must admit that the end has justified the action of the Government in stopping the August strike. Serious dislocation of the carrying industry of the kingdom has been averted, and at any rate the prospect is that we shall carry on for a few years without more than the customary restlessness. There will no doubt be many local and sectional strikes, but the Royal Commission has made a rift between the calmer spirits and the firebrands, between Crewe and Sheffield, which it will take years to bridge over. Indeed, it seems not wholly impossible that the more reasonable men's eyes are at last open to their own supineness, and that they will at length endeavour to win back to themselves the control of their affairs which has been left too long in the hands of the agitator.

We may here very briefly review the whole course of events. The trouble began in 1907, when in the late autumn the railway trades unions, led by the Amalgamated Society of Railway Servants, threatened a general strike in order to enforce recognition and an all-grades programme on the companies. The latter resisted; the Board of Trade intervened, an agreement between the parties was drawn up, and the trouble was averted. The agreement provided for the constitution of boards for the settlement of disputes between the companies and their men. These were, first, Sectional Conciliation Boards, at which sectional questions were discussed; and, secondly, Central Boards, which dealt with matters not settled at the lower board. Finally, if both these boards failed to effect a settlement, as in many cases they did, an arbitrator could be called in. The men's representatives on the Conciliation Boards were elected from the servants of the companies according to their grades. With very few exceptions, members of one or other of the railway unions secured election. This agreement, which was signed by representatives of the companies and the unions in November, 1907, was to be binding upon both parties for seven years, but it never worked well, the men constantly expressing dissatisfaction with the awards. It could, however, well have remained in force until it expired naturally in 1914, when necessary modifications could have been introduced; but patience is not in the knapsack of the agitator. Mr. Richard Bell, who had shown himself a broad-minded and moderate leader, was driven from the secretaryship of the Amalgamated Society, and the more violent section of the union forced itself into power. In August of the present year the agreement of 1907 was torn up. With twenty-four hours' notice the unions presented an ultimatum to all the companies in England, Scotland, and Wales demanding recognition of the all-grades programme. The companies, of course, refused, and on Thursday evening, August 17th, men of all grades all over the country came out. The London and South-Western, of all the great lines, was alone unaffected. The strike lasted for two days. Late on Saturday night the Board of Trade succeeded in inducing the men to have the whole matter placed before a Special Commission, and peace was restored. The Commission commenced to sit on the 25th of August, and, after hearing many witnesses for both sides, issued its report in October. The features of the report were the abolition of the Central Conciliation Board, and the stipulation that no case could be heard by the boards which was not supported by 25 per cent. of the men affected. It also provided that the men in all negotiations with the companies after the preliminary application might have the assistance of a secretary drawn from outside; this made it possible for the unions to have a representative present at the Conciliation Board meetings which was not formerly permitted. Many of the men expressed complete dissatisfaction with the report, and the unions stated roundly that they had never made any promise to accept the findings of the Commission. Trouble was again in the air; but this time the Government was firm, the companies were united and prepared for any eventuality, and the wisdom of a conciliatory attitude was enforced on the union leaders. They at length agreed to accept the report and to meet the companies with a view to discussing the best means of putting the recommendations into operation. This brief conference was concluded on Monday, when it was announced that an agreement had been reached. Practically very little modification of the report has been made. The most important changes are that the proportion of men affected who must back a plea for the consideration of a case is now to be arranged between each company and its men, and need not necessarily be twenty-five; that the companies agree to circularise the men affected one month in advance before making any adverse changes in the rates of wages and hours of work, and such changes coming at once before the Conciliation Board, the men may be represented by someone outside the company—a trade union official, for example—if they so desire; and that new elections will not in many cases be necessary. These are all mere modifications of the Royal Commissioners' report. In addition, four of the companies have promised to put casual workers on the same basis as regards wages as regular workers, and to use their influence with the other companies to do likewise.

It will be seen that to all intents and purposes the report of the Royal Commission has been accepted, and it is not surprising under the circumstances that there is still a large body of men opposed to the agreement. On the other hand, there are a great many who desire to see the new scheme given a trial, and it is quite certain that for many months to come the peaceful party will prevail. There is, of course, nothing approaching the national programme, and there is no recognition. If the non-unionist members care to elect from the outside a perfectly independent person to represent them on the Conciliation Board, and they are powerful enough to outvote the unionists, then the unions will not be represented on the board save by such men as are members of the company. The procedure proposed is, as it should be, quite impartial. We hope the sanguine expectations of the signatories to this agreement may be realised. But we cannot prevent some misgivings. Railway troubles have ceased to be purely labour questions. Socialism, with its handmaiden syndicalism, is forcing its way into all such matters, and we may see the whole railway question raised again for political purposes.

Underground Goods Railways for London.

ELSEWHERE in this issue we call attention to the fourth annual report of the London Traffic Branch of the Board of Trade. To all those connected in any way with London, whether as traders or merchants, or merely as residents, the subject dealt with in the report is of the utmost importance and interest. The congestion of traffic in the streets of the Metropolis is a source of inconvenience, danger, and pecuniary loss to all the inhabitants, and in the devising of a scheme for the relief of the trouble we have one of the most difficult problems facing civic administration at the present moment. The urgency of finding a solution to it is apparent to all using our streets, for the longer some definite scheme of improvement is postponed the more difficult and costly is it bound ultimately to be. This remark is peculiarly appropriate in its application to the suggestions made by the London Traffic Branch in its third and fourth annual reports. During the passage of years vested interests accumulate, site values increase, and what are to-day undeveloped lands may in a few years time be covered by a rising suburb absolutely barring the way to the construction of fresh outlets for traffic. Indeed, at many points the way is already barred. The door which

twenty years or so ago was open is now closed, and can only be battered down at immense expense. Further, "as yae door steiks anither closes," and this unavailability of certain outlets renders nugatory the possibilities of others. The main points being thus occupied, we believe that it is already too late to consider the question of constructing arterial roads and cross connections, such as are described by Sir Herbert Jekyll. At what time during the last century the scheme would have been possible we are not prepared to say. But that it is long since past is, we feel, certain, and it therefore behoves us to look round for some other solution more in accordance with present conditions.

On this subject the report referred to yields, incidentally, a most promising suggestion. As we record elsewhere in this issue, the Post-office is at present considering the construction of an underground electric railway for the transmission of the mails through the heart of London. The suggested line it is true is only to be 6½ miles in length, and will not relieve the congestion to any considerable degree. Even supposing that the system is extended until all the principal post-offices and railway termini in the metropolitan area are linked up, the diminution of the congestion in the streets of London will hardly be noticeable. But the undertaking would serve as an example to other concerns responsible for the carriage of goods, and might eventually induce them to experiment in the same direction. The success of the underground passenger carrying railways is now well assured, and should go far towards the favourable consideration of the analogous scheme of underground transit for goods. It is a well-known fact that our steam railways rely mainly, and in some cases entirely, on goods traffic for their financial success. The suggested underground railways would be in an even better position in this respect because they would be constructed specially to deal with goods, and would not be restricted, as are steam railways, by the necessity for handling goods and passenger traffic simultaneously. With the advent of such underground railways the congestion of traffic in the streets would almost vanish. It would probably be impossible to eliminate entirely all conveyance by road. But it is a matter of every-day observation that it is the slow-moving, ponderous goods vehicles which are responsible for much, if not all, of the present congestion, and for the obstruction attributable to other classes of vehicles not of themselves obstructive. Thus the elimination of part of the slow traffic would reduce the congestion in more than a proportional ratio. From the financial point of view there is every reason to believe that these underground railways would, at least in the central districts of London, meet with gratifying results. The Departmental Committee which investigated the proposed Post-office railway came to the conclusion that the cost of constructing the 6½ miles would amount to £513,000, which is equivalent to an annual expenditure of £31,630. The operating staff, upkeep, &c., would require a further sum of £4100 a year. At the present moment the equivalent mail van service is estimated to cost about £50,000 per annum, so that there is every prospect of the undertaking resulting in a substantial saving.

This solution of the problem presents, therefore, an opportunity for reasonable commercial enterprise. In contrast with this fact, it is to be noticed that the construction of new roads entails an enormous expense, that the capital required would be non-profit earning, and that the upkeep of the roads would therefore constitute a permanent charge on posterity. Doubtless even with a complete system of underground goods railways in the central districts of London there would still be a necessity for improving the roads in the outlying districts, for it is certain that it would not pay to construct such railways to serve the remoter suburbs. But the proposal attacks the very heart of the problem, the congestion within the central districts, and on this all other aspects depend. On the other hand, the scheme for constructing numerous arterial roads leaves largely untouched the improvement of conditions in the centre, and concentrates its attention on the outskirts. The Traffic Branch, it is true, deals briefly in its recent report with the conditions prevailing in the central districts, and makes some suggestions for their improvement. The subject is, however, introduced very hesitatingly, the attitude assumed being that the harm is done and can only be remedied at one or two particularly favourable points. Even supposing it were practicable to construct the roads suggested in the central districts, the congestion would be scarcely a whit less. We would merely have scratched the surface with the hope of diverting a river. The proposed railways could, however, easily be constructed so as not only to handle all the traffic of the day but to be capable of meeting as considerable an expansion of it as the trade of London is likely to experience in the future.

The Electrification of Main Lines.

PERHAPS many who listened to the short discussion on Mr. Philip Dawson's paper read at the Royal Automobile Club last Friday, and published in abstract on another page of this issue, went away asking whether certain railway engineers had done those things they ought not to have done, for all the speakers were loud in praise of the single-phase system, and particularly when used for the electrification of main line railways. A great deal has been said about the reduced output of generators and motors if operated with single-phase current, the reduced efficiency, the impaired regulation, the extra weight of the train, and the cost of the conducting system overhead. There is not the least doubt, however, that the continuous-current exponents have frequently exaggerated these things, and have often ignored the weak points of the system they advocate. It is true that in the case of short runs the energy is almost directly proportional to the train weight, but this no longer applies where the runs are long. The energy on the short runs is almost entirely used in accelerating the train, whereas on long runs the effect of train resistance predominates. It follows, then, that if the train equipment is appreciably heavier for the single-phase system, the continuous current is preferable for suburban sections from this particular standpoint. On the other hand, however, we have to remember that by adopting the single-phase scheme for such service we dispense with sub-stations.

In criticising Mr. Dawson's work in connection with the electrification of the suburban lines of the Brighton Railway, many seem to have overlooked the fact that from the commencement his idea has been eventually to electrify the line to Brighton, and possibly the whole of the system. Many who put forward adverse criticism are now ready to admit that if the Brighton Company is satisfied that the electrification of the whole of its system is profitable then Mr. Dawson has acted wisely in adopting the single phase for the suburban services. There are, however, others who take an entirely different view, and argue that for urban and suburban traffic the continuous-current system is the cheapest with regard to first cost and working expenses, and they therefore advocate this system for these sections on main lines. But these men are usually ready to admit that if extensions were necessary beyond a certain distance low voltage continuous-current working would be unsuitable. They contend, however, that if extension beyond the suburban area becomes necessary the single-phase system could be used in addition to the continuous-current system, thus rendering the duplication of plant a certainty. Now, without favouring any particular system, it cannot be denied that uniformity is a very desirable feature on any railway, and in no case should a dual scheme be adopted if it can possibly be avoided. It is unnecessary to enter into the disadvantages attending the employment of a dual system, for they are sufficiently obvious. If the single-phase system has done all that it is reported to have done on the suburban sections of the Brighton Railway, then it seems highly desirable that very careful consideration should be given to this scheme before putting down low voltage continuous-current equipment on other main lines.

We have mentioned above the reduction in the number of sub-stations, but it is fair to remember that in the single-phase system transformers are used on the train. These naturally have small iron and copper losses, but, on the other hand, they provide an economical means of controlling the motors. Perhaps one of the principal points in favour of the single-phase system is the ease with which the pressure can be raised and lowered, and even the return current can be drawn from the rails to the cables with stationary boosters. Altogether it is eminently suited for high-pressure working, and this is one of the things needed for long-distance main lines.

The great point in Mr. Dawson's paper which should interest and possibly amuse the continuous-current exponents is the statement that those who have had experience of the single-phase as well as the continuous-current systems both here and abroad are satisfied that the former is quite as economical for suburban working as the latter. The statement is not new, but in the case of the Brighton Company we believe we are correct in saying that up to the present no figures have been published to support it. Whatever arguments may be brought forward against single-phase electrification, it cannot be denied that it is a simple system, and one which lends itself to unlimited extensions. The elimination of the usual rotary converters and their losses, as well as the sub-station attendants, make it very tempting, but it is necessary carefully to consider all sides of the question in order to arrive at the net efficiency. Mr. Dawson has brought forward some figures showing sub-station costs, but it is obviously unfair to base arguments on one item only. It would be equally unfair of the continuous-current exponents to champion their system on the score of the lower cost of the track equipment. What is wanted more than anything at present is a clear statement as to the total cost of operating both systems, omitting nothing, distorting nothing, palliating nothing. Only then shall we know which is economically the better.

High-speed Petrol Engines.

THE system of taxing motor cars according to their power—or rather according to the bore of the cylinders of the engine—has proved a great incentive to engine designers to seek higher speeds and improved efficiencies. Hence the possibility of making a small engine perform the work which could formerly only be done by one of much larger dimensions running at moderate speeds. We are not immediately concerned with the consideration of who is responsible for the change—the makers or the public—or whether the high-speed engines will prove as durable as their predecessors, but a word of warning is necessary against the tendency to go to extremes in the adoption of small bore, long stroke, high-speed motors. Three or four years ago speeds of 1000 or 1200 revolutions per minute with short strokes were considered high, whereas 2000 to 2500 revolutions and upwards are now becoming common. No trouble need be feared in running well designed small engines at this speed for short periods, but when an engine is overloaded to such an extent that the lower gears have to be brought into use for extended stretches, the maximum speeds of revolution will mean short life.

Provided the reciprocating parts are light enough, the crank shaft carefully balanced, and the lubricating system effective, the high speeds are easily attained, but designers find it is not so easy to maintain a high mean effective pressure or volumetric efficiency throughout the whole range of speeds. Up to a certain speed the mean effective pressure of most petrol engines is fairly high, but after that it commences to fall away, and the power curve begins to droop to a serious degree. It is not sufficient to provide a high-compression ratio, a certain shape of combustion chamber, a correct setting of the valves and accurate timing of ignition, although all these points count in the design of a high-speed engine. The heat value of the fuel has been shown to have great influence on the mean effective pressures, and designers of modern carburetters have shown their appreciation of this fact. To obtain high mean effective pressures at the highest speeds, however, high volumetric efficiency combined with high compression is the feature to be aimed at. In an able paper on "Engine Design for Taking Advantage of H.P. Rating Rules," which was read before the Institution of Automobile Engineers on Wednesday last, Mr. L. H. Pomeroy had something to say on this subject. He stated that high-speed petrol engine design was rapidly resolving itself into a competition between designers, who were all trying to graft the largest valve gear possible on to the smallest cylinder. He pointed out that this was a perfectly healthy tendency, but it had its limits, for the following reasons:—As the diameter of the valves approaches that of the piston, the compression space becames unreasonably large, and with a correspondingly low compression the engine is limited in speed owing to sluggish firing, and the object in view is defeated. As an illustration of the point under notice the author mentioned the instance of an engine 3¼in. bore, with 2¼in. valves. In this engine the combustion space had a volume of 9 cubic inches, and, with a compression ratio of 5 to 1, a minimum cylinder capacity of 36 cubic inches was necessary, and a stroke of 4.7in. By means of a calculation on the flow of gases the author showed that this ratio of valve area to cylinder capacity was sufficient to permit an engine speed of 5000 revolutions per minute, and a maximum horse-power of 75, if nothing intervened to prevent this speed being realised. Now, these high speeds call attention to the desirability of simplicity, fewness

of parts, and lightness of the reciprocating members. Lightness means using the highest possible quality of material. But it is useless to provide a light steel piston and light connecting-rod with a heavy big end, as is sometimes to be seen. We think, however, there can be no doubt that those members of the motor trade who are striving to produce these high-speed engines—whether they are a practical commercial proposition or not—are adding to their knowledge of the science of metals, and of the results of detail alterations of engines. The effect of these items of information will usually be reflected in their products.

On the subject of ignition of the charge the author of the paper referred to insists upon the fitting of a first-class magneto as essential where high mean effective pressures are concerned. Recent experiments have shown that it is possible to fire a charge to produce a high M.E.P. at a speed of 3000 revolutions per minute. He has found no advantage, however, in the application of "series" or two-point ignition, and no difference in horse-power is, he says, appreciable at any speed owing to the simultaneous firing of the charge at opposite sides of the cylinder. In this respect his experience is at variance with that of the builders of large gas engines, who find a distinct gain in power by the simultaneous firing of the explosive charge at two points, and it would be interesting to ascertain more definitely than at present the limits of single point and series ignition systems.

LITERATURE.

The Practice of Copper Smelting. By Edward Dyer Peters. McGraw-Hill Book Company, New York, and 6, Bouverie-street, London, E.C. 1911.

THE author's "Modern Copper Smelting" has for many years been a recognised handbook for the copper smelter, and has been through many editions. The present work is intended to supplant this, and to form a companion book to the author's "Principles of Copper Smelting." The main feature of the book under notice consists in its records of the actual procedure at some of the most prominent American smelters. It is such details of working practice which make the American handbooks so much sought after by metallurgists the world over—there being few mining centres where these books are absent from the office or the laboratory, as far as our own experience goes, at any rate. Of course, the American writer has a great advantage over his European brother in the ease with which he can get permission to visit important works, and, what is more, to publish the details laid bare to him. Professor Peters, we know, has done a good deal more than lecture on metallurgy and pay visits to works; he has had actual and long experience of practical routine in the works, and has every qualification therefore to write fully on American practice. The result is an extremely valuable compendium of facts and deductions bringing up to date the subject of the dry extraction of copper from its ores.

The wealth of detail makes it, of course, an utterly impossible task for us to attempt to follow the author along its pages in the prescribed limits of a review, and we must perforce be content with commenting at random on one or two points which suggest themselves as of some general interest. The book does not treat of the extraction of copper by the wet methods, the author expressing the opinion that a mere compilation of existing literature on the subject would be of little value. He recognises to the full the importance which would attach to a comprehensive work on the subject, but says that an author with the necessary knowledge is not yet available. A remark to this effect from an American source is tantamount, we take it, to an opinion that a sufficiently competent writer does not exist, or else we should soon have a volume on the subject replete with such valuable information as is to be found in the book under review.

In Europe, however, such a statement would merely be taken to mean that the writer is not available or forthcoming—in other words, that the firms in whose service he has gained his intimate knowledge, or with whose fortunes he is identified, decline to allow him to appear in print for the general welfare. We think we are quite correct in saying that the wet processes of copper extraction are practised to a much larger extent in Great Britain than in America, the raw material not being low-grade siliceous ores, but the cinders from Spanish and Norwegian cuprous pyrites, the sulphur of which has been utilised in the vitriol manufacture. There is a ready market in Britain for this burnt ore with its 3 to 4 per cent. of copper, and there is considerable competition in contracting for the available supplies.

In Chapter II., which deals with the sampling of copper ores, attention is drawn to the controversial point of accurately determining the moisture in the bulk. British contracts usually contain the clause that the moisture shall be determined at the time of weighing, and this seems to be done in America by taking grab samples. In England, however, with low-grade ore such as cupriferous pyrites the usual procedure is to take the moisture in each sample of 200 to 300 tons after the ore has passed the crusher or hammers and has been stamped on the plate to pass a 20-mesh. This procedure is undoubtedly against the buyer, but he generally manages to get a little of his own back by volatilisation of sulphur when the moisture determination is subsequently made in the Cornish pan. This hallowed procedure still reigns in England, while on the Continent heating on a sand bath with a thermometer inserted in the ore is the rule. In America we note that drying over steam pipes is adopted, though nothing is said as to the temperature. But we cannot stay longer at this chapter, the subject of which we imagine will sooner or later be promoted to the dignity of a volume to itself.

In Chapter V. the roasting of sulphide ores is treated in a comprehensive manner, full details being given of the McDougall roasters at the Washoe smelter of the Anaconda Company. The use of mechanical roasters is more general in America than in England, though the Herreshoff furnace, especially for the burning of pyrites fines in vitriol works, is now being increasingly employed in England. An English invention, Spence's mechanical roaster for fines, was at one time employed in the States. This and the rotary roaster used in South Wales are not referred to in the book, an omission which probably implies that they have been discarded in modern practice. The once important topics of heap and stall roasting receive but brief notice, because, as the author points out, these processes have largely sunk into desuetude with the advent of pyritic smelting, in which the sulphur formerly thrown away is now utilised as fuel in the blast furnace. And quite apart from this economy in working, modern legislation has made it more and more difficult for copper works to send out their fumes broadcast. *Apropos* of this we may mention that at the Röros copper mines in Norway, where heap roasting of siliceous pyrites is employed, there is a total cessation of work during the summer months in the interests of the hay crop. In the chapters devoted to true pyrite smelting and partial pyrite smelting in the blast furnace, those who still follow the older reverberatory furnace methods will find a masterly summary of the developments to date, with a full discussion of the reactions involved. The question of the utilisation of fines has, with the adoption of pyritic smelting, become of increased importance, and in addition to what is included in the chapters on smelting, the topic has Chapter XIII. allocated to it. The details regarding the briquetting of fines are of much interest. Water alone, without any binding material, was successfully used in England many years ago, though the product was not of course, used in the blast furnace. Procedure, however, with regard to briquetting varies in England, and there is a tendency in individual works jealously to guard their respective methods as trade secrets.

Under recent clauses in our Alkali Acts copper smelters are now expected to the best of their ability to condense the sulphurous gases they evolve. The important point in this connection is as to how far it is commercially feasible to utilise the gases in the manufacture of vitriol, and it is generally agreed that if this course were followed a glut of acid would result. If this is the case in England the position is even worse in America, because of the entire absence of demand for acid in most copper-smelting centres. Of late years the subject of smelter smoke and fume has become acute in America, where the farmers have risen in arms against the damage done, or said to have been done, to vegetation. In the author's opinion the extended use of the bag-house, combined with neutralisation of the acid gases and final discharge of the residual gas at a good altitude is the only practicable method of procedure in the majority of cases, though he cites an instance where the gases have been utilised with profit for acid-making. The thirteenth and last chapter in the book is entitled "Miscellaneous," the topics discussed including the cost of production of metallic copper and the delicate matter of the somewhat strained relations which are by no means an uncommon feature in dealings between the mine owner and the smelter. With regard to the cost of production we note that this varies from 7 to 17 cents per lb., 10 or 11 cents being a common figure, corresponding to about £47 per ton. It may be added that if it were not for the recovery of the small quantities of the precious metals contained in the ores the cost of production would be higher, and in some cases prohibitive. With respect to the buying of ore the smelter has a doughty champion in our author, who certainly makes out a good case for the returning charges in common use. In many cases the mine owner knows nothing of the smelting process, and perhaps if he read this chapter he would be less inclined to call the smelter hard names after receiving notification of the returning charges, draft, &c., which go to reduce his payment for ore sold. Possibly, however, he might still consider himself an ill-used person, and cherish the idea that the author holds a brief for the smelter, and that the case for the miner has not been fully presented. The position may be different in America, but in England the smelter will not now pay any more for copper ores containing calcite and iron gangue than for siliceous ores, as there is plenty of the former to be got. We have now exhausted our available space, and we close this important book with merely saying that the illustrations are numerous and well selected.

In a technical work we are not disposed to attach undue importance to any little defects on the literary side, and really it is only because this book is in general so excellently written that we mention the fact of the slight shock we have experienced in its perusal owing to the rather prevalent misuse of "and which."

Building Construction. Volume I. By Beresford Pite, Frank T. Baggallay, H. D. Searles Wood, and E. Sprague. Edited by F. M. Simpson. London: Longmans, Green and Co., 39, Paternoster-row, E.C.

THIS work should prove of great value to the student studying for examination. The preface, however, rather tends to mislead the reader by saying that "Building construction in itself is merely a skeleton; its effective covering is architecture." With this we thoroughly disagree, and trust the time will never come when buildings will be constructed with their elevations masked in architectural ornament on the principle of internal decorative art. Rather should the requirements of plan and construction give life to the building by appearing on its elevation and explaining its utility, and the building up of all architectural expression is dependent upon the capability of the designer to combine these two necessities.

We note the use made of the camera to illustrate different methods of finishing stone surfaces, and feel that this might be extended with advantage to explain more clearly the true method of bonding in brickwork, by taking photographs looking down on the walls while in process of construction. This would give the student a practical view of the subject, the accurately drawn diagrams still assisting him to satisfy the examiner. The wisdom in not entering into the question of double-framed floors and stud partitions, and also in leaving out the elaborate details of the king and queen post roof trusses, is to be commended as showing the tendency throughout the work to be thoroughly up to date. Although the first chapters are in some places very elementary, the later ones relating to beams and girders, struts and columns, and the designing of framed structures are so advanced that the publication should prove not only of value to the student, but also to the practising architect, and for that reason will no doubt find a place in the architect's library.

SHORT NOTICES.

Railway Operating Statistics. By C. P. Mossop, head of Statistics Department, North-Eastern Railway. London: The *Railway Gazette*.—In Mr. Sam Fay's presidential address to the Railway Students' Union of the London School of Economics on October 24th he made some humorous references to the use of statistics, and although no mention was made of ton-mile figures, there is no doubt that Mr. Fay had these in his mind. He then added: "Good reliable statistics are absolutely necessary in railway management." Opinions differ as to the worth of ton-mile statistics, but, in view of the greater expenses that are, and will be, thrust on British railways, any means that will help to make the working more profitable should be welcomed. The train-load on the North-Eastern has increased from 81.40 tons in 1902 to 126.52 tons in 1910. Not all this can be due to the adoption by that company of ton-mile figures, but anyone who reads Mr. Mossop's book must admit that they have been a means to this desirable end. The author is responsible for the preparation and compilation of the North-Eastern ton-mile statistics, and in this work it is clearly shown how this is done, what is revealed thereby, and the lessons to learn therefrom.

The Sewerage of Sea Coast Towns. By Henry C. Adams. London: Crosby Lockwood and Son.—This little book is intended primarily for those engineers who, having a general knowledge of sewerage, are called upon to prepare a scheme for a sea coast town, or are desirous of being able to meet such a call when made. There are fifteen chapters. The first three are devoted to tides and current observations, and contain some interesting reading. Chapter IV. deals with the selection of a site for the outfall, and it hinges largely on what has preceded it. Chapters V., VI., VII., and VIII. treat of volume of sewage, gauging the flow in sewers, rainfall, and storm water in sewers. Wind and windmills is the subject of Chapter IX., and that of Chapter X., the design of sea outfalls. The important question of the action of sea water on cement receives attention in Chapter XI. In Chapter XII.—diving—the author does not add anything to the general knowledge, but the instructions given so far as they go are correct. Chapter XIII. gives rules for the discharge of outfall sewers. The last two chapters discuss trigonometrical and hydrographical surveying respectively.

"Verbal" Notes and Sketches for Marine Engineers. By J. W. Sothern. Seventh Edition. Glasgow: James Munro and Co., Limited. 1911. Price 10s. 6d. net.—This useful book has been practically re-written and re-illustrated, some hundreds of new and original sketches being included in it. This has, not unnaturally, increased its size, and it has been found necessary to omit the indicator diagram section, which, however, is now issued as a separate publication under the title of "Marine Indicator Cards." A special section on "Valve Settings" has now been included—a subject, as the author remarks, which is usually neglected in ordinary text-books, and which he hopes will be found of use to junior engineers, among whom the subject is, speaking generally, very imperfectly understood and appreciated. The boiler section has received particular attention, and a new section—"Workshop Practice"—has been added. In comparing the sixth and seventh editions we see in the latter very many changes and amplifications which should all tend to increase the utility of an already valuable book of reference.

"Hütte" des Ingenieurs Taschenbuch. Vols. I. and II. Price 13 Mk. cloth, 15 Mk. leather; also *Hütte des Bauingenieurs* (forming Vol. III. of *Hütte des Ingenieurs Taschenbuch*). Price 9 Mk. cloth, 10 Mk. leather. The Vols. I., II. and III., 18 Mk. cloth, 21 Mk. leather. Berlin: Wilhelm Ernst u. Sohn. Twenty-first edition, thoroughly revised, enlarged, and with many new illustrations.—A considerable number of sections and sub-sections appear for the first time in this edition. The new sections include the mechanics of aeriform bodies, motor vehicle construction, illumination, earthwork, cranes and transporters, town-planning and waterworks. New sub-sections include additions to the mathematical and mechanical chapters; fuels and combustion; additions to the sections on power plant, minerals, shipbuilding (marine turbines being added); electrical engineering and railway rolling stock. Many chapters have been practically re-written, and, in short, these volumes should now prove to be thoroughly adapted to the needs of the modern engineer in every department of his varied science.

Wood Pulp and its Uses. By C. F. Cross, E. J. Bevan and R. W. Sindall, with the collaboration of W. N. Bacon. London: Constable and Co., Limited. 1911.—This forms one of the excellent "Westminster" series of technical books published by this firm. It is in no wise behind any of its fellows in interest, and can be read with enjoyment by the most untechnical, though technicalities are by no means omitted. In it the whole process of paper-making is discussed. First we have a dissertation on the various kinds of wood and their structural elements. Then the constituent cellulose comes under review. Sources of supply are next dealt with, and then the authors turn to processes of manufacture by means of which the raw wood is converted first of all into pulp and then into paper, board, &c. "The Utilisa-

tion of Wood Waste," "Testing of Wood Pulp for Moisture," and "Wood Pulp and the Textile Industries" are the titles of the next three chapters, and lastly there is a series of specimens of paper made from wood pulp with details of the weight, thickness, strength, composition of each.

Pumping Machinery: A Treatise on the History, Design, Construction and Operation of Various Forms of Pumps. By Arthur M. Greene, jun. London: Chapman and Hall, Limited. 1911.—Mr. Green is professor of mechanical engineering at the Rensselaer Polytechnic Institute, and the book may therefore be regarded as having been primarily written for university students. It contains an historical outline of the development of pumping machinery, then a description of the action of a number of common forms of pumps, and finally a dissertation on the methods of design of pumping apparatus.

The Fire Brigade Handbook. By James Compton Merryweather. Second edition. London: Merritt and Hatcher, Limited. 1911.—The original issue of this book was made in 1888. Its intention was to instruct volunteer firemen in their duties and in the use of the fire-fighting appliances then in vogue. So many changes and innovations have been made in the latter that it has been found expedient to issue another edition, so as to bring the contents up to date. It will be found to contain much useful information on the subject.

BOOKS RECEIVED.

Stability in Aviation. By G. H. Brian. London: Macmillan and Co., Limited, St. Martin's-lane, W.C.

Elementary Graphic Statics. By W. J. Crawford. London: Charles Griffin and Co., Limited. Price 2s. 6d. net.

Hydro-electric Practice. By H. A. E. C. von Schon. Second edition. London: J. B. Lippincott Company. Price 25s. net.

The Railway Library, 1910. Second series. By Slason Thompson. Chicago: The Gunthorp-Warren Printing Company.

Boiler Draught. By H. Keay Pratt. London: A. Constable and Co., 10, Orange-street, Leicester-square. Price 4s. net.

Power-house Design. By J. F. C. Snell. London: Longmans, Green and Co., Paternoster-row, E.C. Price 21s. net.

Arabic (Self-taught) Syrian. By A. Hussam. Fourth edition. London: E. Marlborough and Co. Price 2s., cloth 2s. 6d.

The Heat Treatment of Tool Steel. By Harry Brearley. London: Longmans, Green and Co., Paternoster-row, E.C. Price 10s. 6d.

The "Mechanical World" Electrical Pocket-book, 1912. Manchester: Emmott and Co., Limited, 65, King-street. Price 6d. net.

Metallurgy. Vol. I. By Herbert Lang. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 12s. 6d. net.

The Theory of Structures. By C. M. Spofford. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 17s. net.

Forecasting Weather. By W. N. Shaw, F.R.S. London: A. Constable and Co., 10, Orange-street, Leicester-square. Price 12s. 6d. net.

The Principles and Practice of Electric Wiring. By A. Bursill. London: Longmans, Green and Co., Paternoster-row, E.C. Price 3s. net.

Plan of Seattle: Report of the Municipal Plans Commission, submitting Report of Virgil G. Bogue. Seattle, Washington, America.

The London Chamber of Commerce and its Work. By C. E. Town. London: The London Chamber of Commerce, Oxford-court, Cannon-street.

Municipal Franchises. By D. F. Wilcox. Vol. II. London: A. Constable and Co., Limited, 10, Orange-street Leicester-square, W.C. Price 21s. net.

A Text-book of Physics: Heat. By J. S. Poynting and Sir J. J. Thomson, F.R.S. Fourth edition. London: Charles Griffin and Co., Limited. Price 15s.

Reinforced Concrete Construction. By Henry Adams and Ernest R. Matthews. London: Longmans, Green and Co., 39, Paternoster-row, E.C. Price 10s. 6d. net.

Geological and Topographical Maps: Their Interpretation and Use. By A. R. Dwerryhouse. London: Edward Arnold, 41 and 43, Maddox-street, W. Price 4s. 6d. net.

A Compendium of Aviation and Aërostation. By Lieut.-Col. H. Hoernes, with a preface by J. H. Ledeboer. London: Charles Griffin and Co., Limited. Price 2s. 6d. net.

Realitäten, Abstraktionen Fingerungen und Fiktionen in der Theoretischen Mechanik. By O. E. Westin. Stockholm: Kungl Boktsyckeriet, P. A. Norstedt und Söner.

A Manual of Civil Engineering. By W. J. Mac Quorn Rankine. Twenty-fourth edition. London: Charles Griffin and Co., Limited, Exeter-street, Strand. Price 16s. net.

Transactions of the American Institute of Chemical Engineers. Vol. III. 1910. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. Price 25s. net.

Transactions of the Institution of Naval Architects, 1911. Vol. LIII., Part I. Edited by R. W. Dana, M.A., M. Inst. C.E. London: Henry Sotheran and Co., 37, Piccadilly.

Chemistry for Engineers and Manufacturers. By Bertram Blount and A. G. Bloxam. Second edition. London: Charles Griffin and Co., Limited, Exeter-street, Strand. Price 14s.

The Guide to South and East Africa, 1911-1912. Published for the Union-Castle Mail Steamship Company, Limited (Donald Currie and Co., Managers). London: Sampson Low, Marston and Co. Price 2s. 6d.

Deutscher Ausschuss für Eisenbeton. Heft XII. Versuche mit Eisenbetonbalken zur Ermittlung der Widerstandsfähigkeit verschiedener Bewehrung gegen Schubkräfte. Zweiter Teil. Von Baudirektor Professor C. Bach. Berlin, W. 66, Wilhelmstrasse 90: Wilhelm Ernst und Sohn. Preis geheftet 14 marks.

TWIN-SCREW REFRIGERATED MEAT STEAMER.

THE twin-screw vessel El Zarate, illustrated herewith, has recently been completed by the Greenock and Grangemouth Dockyard Company, Limited, of Greenock and Grangemouth, for the Smithfield and Argentine Meat Company, Limited, of 58, West Smithfield, London, E.C., Buenos Aires, and Zarate, Argentina.

This vessel is to be employed in conveying chilled and frozen meat from the company's up-river works at Zarate to the ocean steamers engaged in carrying refrigerated meat between the River Plate and British ports. The dimensions of the vessel are 210ft. between perpendiculars by 42ft. beam, and 11ft. 3in. depth moulded to main deck. She is built to the British Corporation specification for river service, and has her propelling machinery fitted aft. A bridge deck is fitted for 120ft. of the vessel's length amidships, which, in conjunction with the lower holds, provides the space for the insulated cargo, amounting in all to 60,000 cubic feet. Underneath the insulated holds the vessel has a double bottom built on the cellular principle, and the forward and aft peaks are fitted as ballast tanks to enable her to be trimmed for the very light draught of water available in the upper reaches of the river.

She is designed to carry a total deadweight of over 400 tons with a draught in fresh water of 6ft. 6in., and on trial in this country the engines maintained a speed of 10.4 knots. The vessel is divided by five steel bulkheads, and the upper and lower insulated compartments are each divided into two chambers. These are insulated in a thorough manner by granulated cork and double thicknesses of tongued and grooved timber. The flooring is of elm, with water-tight paper fitted between the two thicknesses of lining. Practically the whole of the inside of the steel plating of the vessel is coated with Wailes Dove's bitumastic enamel to preserve it from damp or corrosion, while all the timber in connection with the insulation has been treated to preserve it from decay.

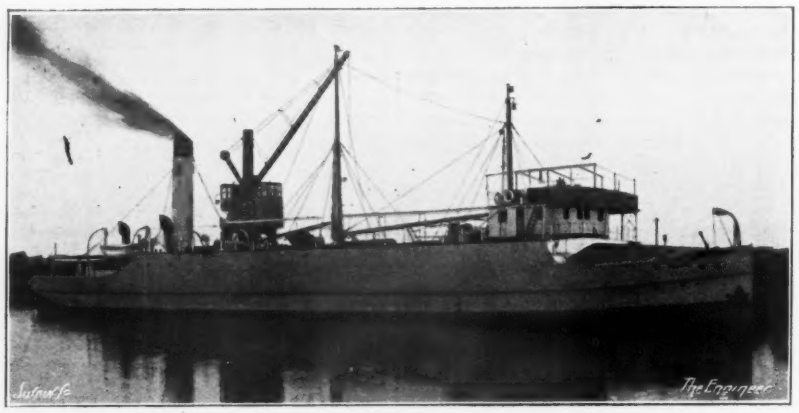
Giving admission to each of the two upper compartments, and communicating with the lower compartments, there is a trunk-way extending across the breadth of the vessel, with hatches on each side of both decks. Winches, derrick posts, and derricks are so arranged that the cargo can be readily and quickly swung into or out of these hatches and into those of the ocean-going steamers. The hatch covers are insulated in the same manner as the rest of the hold. Each hold is provided with thermometer tubes for taking the temperature. A complete system of meat rails and switches has been installed, and special attention has been given to securing convenience in loading and discharging the cargo. A number of sides of beef, slung on a portable beam, can be lifted together by a derrick, swung inboard, and the beam dropped into sockets arranged in the hatches. The quarters of beef are run forward from this on to the system of overhead rails without being lifted or touched by hand. Special switches on the overhead rails are designed and arranged so that the meat can be run on to any of the rails in any of the different chambers. The rails run fore and aft in each of the chambers, and are spaced about 12in. apart. They are suspended from the beams by metal hangers, and are provided with rollers upon which the quarters of meat can be hung and run into any desired position.

The entire refrigerating plant has been manufactured and installed by the Haslam Foundry and Engineering Company, Limited, of Derby. The installation consists of a horizontal duplex refrigerating machine of the ammonia compression type, with two compressors placed behind, and driven from the tail-rods of a compound steam engine. The deep baseplate of the machine contains the ammonia compressor coils in two separate compartments. The brine is cooled by two evaporators of the usual marine type, and is circulated by two direct-acting duplex steam brine pumps. The whole plant is so arranged that one-half can be at work while the other half is stopped for repairs, and is of such capacity that one-half will maintain the whole cargo at a suitable temperature. An independent steam surface condenser is provided, and a separate duplex water circulating pump. It should also be remarked that a suitable temperature for chilled or frozen meat can be maintained in any one compartment independently of that in the others. The chambers are cooled by brine circulated through galvanised wrought iron pipes arranged close under the ceilings.

The propelling machinery is placed at the aft end of the vessel, and the refrigerating machinery in a separate compartment immediately in front of the main engine-room. Coal bunkers of large capacity are fitted alongside the boilers. The accommodation for the crew, officers, and engineers is of a modern and comfortable description. The crew are accommodated underneath the main deck forward, and the officers in a large deck-house on the top of the navigating bridge, each officer and engineer having a room to himself, well lighted and ventilated, and with mosquito screens fitted throughout. Baths and other sanitary appliances are installed with a gravitation water system, and the whole of the accommodation has been fitted up to suit the climate in which the vessel is to be worked. A lamp room, bathroom, galley, pantry, store-rooms, and cook and stewards' room are arranged at the after end of the bridge deck.

The vessel has a heavy wood belting all round, and possesses a steam windlass forward, a steam capstan aft, two steam winches on the bridge deck, steam steering gear on the top of the deck-house, and hand steering gear aft. The derricks are of special construction to suit the loading arrangements of the vessel and the spacing of the hatches on the deep sea steamers. They are capable of lifting a load of two tons. An electric light installation, including navigation lights, lights in the holds, and deck cargo clusters has been fitted up in the vessel by Siemens Brothers. Canvas awnings are provided fore and aft all over the vessel, and she is fitted with boats and life-saving appliances in accordance with the requirements of the Board of Trade.

The propelling machinery, which has been constructed by Cooper and Greig, of Dundee, consists of two sets of compound surface-condensing engines. The pistons are specially deep; those for the high-pressure cylinder are fitted with Ramsbottom rings, and those for the low-pressure with Cameron's patented rings. The bearings are of bronze, and specially long for quick running. The condensers are double, with extra large cooling surface for maintaining a high vacuum in tropical waters. The circulating pumps are of the centrifugal type. Woodison's automatic feed pumps, and a Clarke-Chapman low-service ballast pump to deliver 200 tons per hour are also to be found among the auxiliary machinery. The boilers are two in number, and are of the cylindrical multitubular type, for a working pressure of 140 lb. They are fitted with Deighton's furnaces and Howden's forced draught. The whole of the machinery has been constructed to the British Corporation and the Board of Trade's requirements.



REFRIGERATED MEAT STEAMER EL ZARATE

DURBAR HONOURS.

THE list of honours conferred by the King in connection with the Durbar at Delhi is extensive, and we are pleased to see that the engineering and kindred professions have by no means been forgotten. Among many appointments we observe the following:—

To be K.C.S.I.

Sir Treveredyn Rashleigh Wynne, K.C.I.E., M. Inst. C.E., Chairman of the Railway Board.

To be C.S.I.

Charles Ernest Vere Goument, M. Inst. C.E., Indian Public Works Department, Chief Engineer and Secretary to the Government of the United Provinces of Agra and Oudh, Buildings, Roads and Railway Branches.

George Gilbert White, M. Inst. C.E., Chief Engineer and Secretary, P.W.D., Government of Burma.

Colonel Sidney Gerald Barrard, R.E., F.R.S., Officiating Surveyor-General of India.

George Moss Harriott, C.I.E., M. Inst. C.E., Chief Engineer and Secretary, P.W.D., Central Provinces.

Gilbert Thomas Walker, D.Sc., F.R.S., Director-General of Indian Observatories.

John Charles Burnham, Manager and Chemist to the Cordite Factory, Aruvankadu, Nilgiri Hills.

Brevet-Colonel Thomas Francis Bruce Renny-Tailyour, R.E., Superintendent of Surveys, Southern Circle.

Major Alain Chartier de Lotbinière Joly de Lotbinière, C.I.E., R.E., P.W.D., State Engineer, Kashmir.

Brevet-Colonel Robert Smeiton Maclagan, C.B., R.E., Superintending Engineer, Punjab.

To be K.C.I.E.

The Hon. Francis Joseph Edward Spring, C.I.E., Member of Council, Institution Civil Engineers, P.W.D. (retired), Chairman of the Madras Harbour Trust Board.

To be C.I.E.

Henry Hubert Hayden, Director of the Geological Survey of India.

George Cunningham Buchanan, M. Inst. C.E., Chairman and Chief Engineer of the Rangoon Port Trust.

Colonel William Burgess Wright, V.D., General Traffic Manager, Madras and Southern Mahratta Railway.

Cecil Archibald Smith, M. Inst. C.E., Chief Engineer and Secretary to the Government of Madras, P.W.D.

To be C.V.O.

John Cromie Lyle, Chief Engineer, Durbar Railways.

To be M.V.O., Fourth Class.

Thomas Robert John Ward, C.I.E., A.M. Inst. C.E., P.W.D., Superintending Engineer, Western Jumna Canal Circle, Punjab.

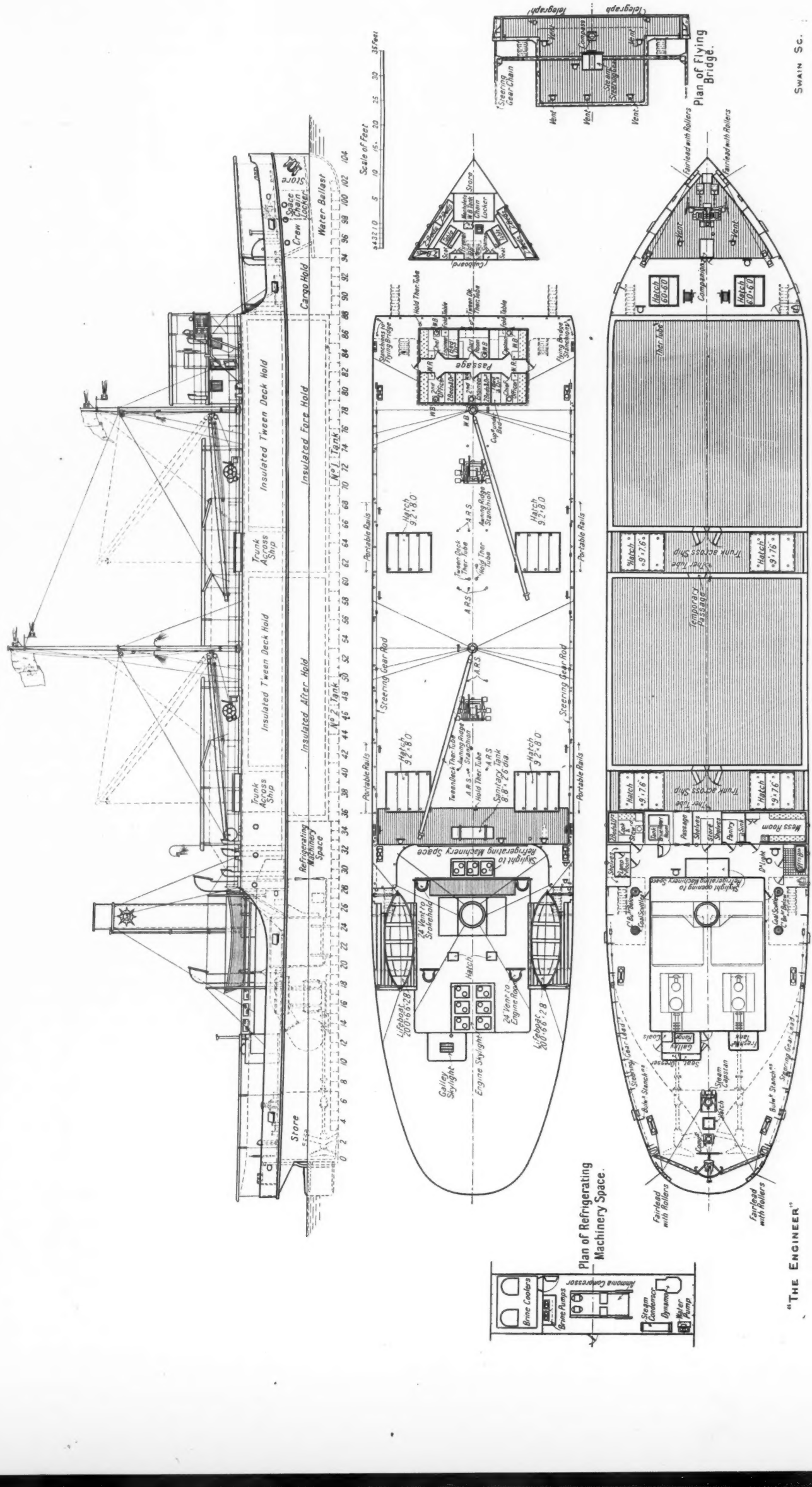
Major Sidney D'Aguilar Crookshank, R.E., Executive Engineer, P.W.D., United Provinces of Agra and Oudh, Superintendent of the Durbar Works.

John Scott Pitkeathly, Electrical Inspector to the Government of the United Provinces of Agra and Oudh, and Electrical Engineer to the Durbar.

TWIN-SCREW REFRIGERATED MEAT STEAMER EL ZARATE

THE GREENOCK AND GRANGEMOUTH DOCKYARD COMPANY, LIMITED, BUILDERS

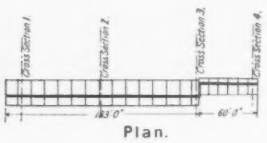
(For description see page 618.)



REINFORCED CONCRETE RETAINING WALL AT BURY

A REINFORCED CONCRETE RETAINING WALL.

AN interesting example of reinforced concrete retaining wall has recently been constructed for the Town Council of Bury in connection with its electricity supply station. It embodies certain novel features which are well worthy of attention.



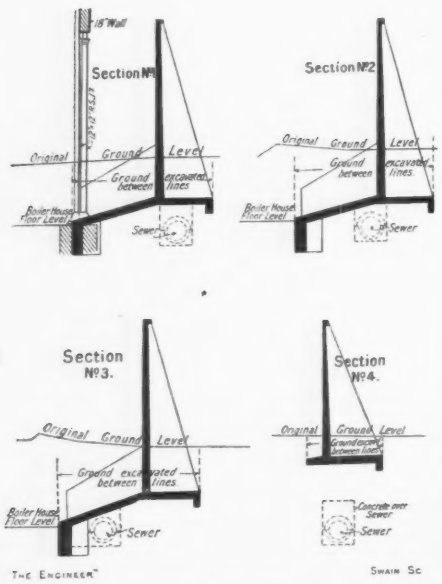


Fig. 1—SECTIONS OF THE WALL AT DIFFERENT POINTS

The boiler-house of the Bury supply station adjoins the main line of the London and North-Western Railway, and the desire of the railway company to widen the line for the heaviest main-line traffic rendered it necessary that a retaining wall should be erected close to the wall of the boiler-house, as it was impossible to run the new lines in the manner in which the original line was carried, namely, on a simple ramped earth embankment. It was arranged that the retaining wall should not come right up against the wall of the existing building, for in that case the boiler-house would probably have had to have been reconstructed, and the fact that the retaining wall was to be some feet away from the boiler-house led the engineer to the Bury Corporation to employ the space between it and the building partly as a coal bunker, and a somewhat special construction was determined upon in consequence.

The above engraving, which is reproduced from a photograph of the complete wall, gives some idea of its general form, and Fig. 1 gives diagrammatically certain sections of the wall at different points, and shows also the relative positions of the chief part of the retaining wall and the boiler-house. At one end, where the retaining wall extends beyond the boiler-house, it is not required to serve the purpose of a coal bunker, and here it has been made less in height and of somewhat different construction. The point where the alteration in form takes place may be seen in the plan at the top of Fig. 1. In this the smaller wall is at the right-hand end side. It extends for 60ft., whereas the major part of the wall consists of the larger structure, and extends for about 183ft. The general form of the walls at various points is shown in this engraving.

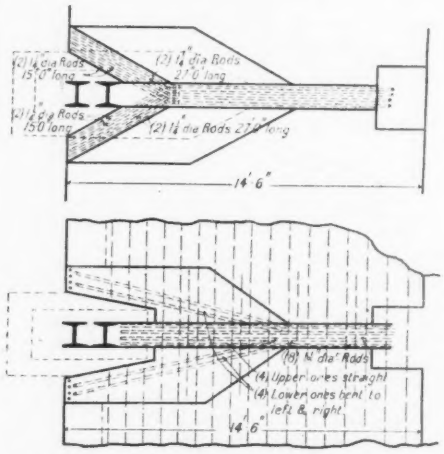
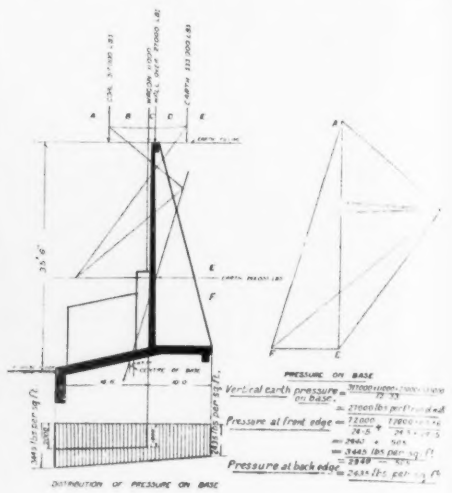

(2) 1¼" dia Rods 15'0" long
(2) 1¼" dia Rods 15'0" long
(2) 1¼" dia Rods 21'0" long
14'6"
(6) ¾" dia Rods
(4) Upper ones straight
(4) Lower ones bent to left & right
14'6"

Fig. 3—DETAILS OF BIFURCATED BUTTRESSES

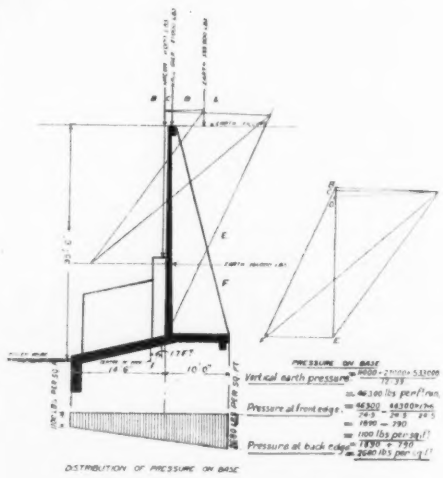
It will be noted from this and from Fig. 2, which shows a more detailed plan of the wall to a larger scale, that there is an existing brick sewer running along the whole length of the work. This sewer comes at different positions under the wall and bunkers, because it traverses them at an angle. The various methods of crossing it are shown in Fig. 1. It will be observed that in some places the floor of the wall came of economy, the buttresses on the earth or railway side being carried to the top, while on the boiler-house side they were only carried about a third of the way up. The buttresses on the boiler-house side are peculiar, in that they are bifurcated, as may be seen in Fig. 2, the reason for this being to avoid the existing stanchions of the boiler-house. These inner buttresses are used to form divisions between the bunkers in which the coal is stacked. Sections of the larger and smaller types of wall are given in Figs. 6 and 7.



CASE 1 — BUNKERS FULL.

Fig. 4—STRESS DIAGRAM

The base of the wall is carried down with a toe on each edge, where it comes under the coal bunkers, to increase the resistance to sliding. The smaller wall, however, only has a toe on the outer edge of the base, as may be seen in Fig. 1. Fig. 3 shows the bifurcated buttresses in plan in greater detail, and gives the arrangement of the reinforcement both at the top and bottom. At one end, owing to the fall in the sewer, the base of the wall had to be raised 2ft. 6in., necessitating somewhat different section. At the extreme end, shown to the left of Fig. 2, the work was terminated with half a bay as it were, instead of with a buttress. This was done as there was a possibility at some future time of extending the boiler-house in this direction. The retaining wall would then have to be extended likewise. That had the result of terminating the wall so that the last portion of the base had to be carried as a cantilever extending beyond the buttress. In order to form a road for railway wagons to bring coal to the bunkers, a dwarf reinforced concrete wall has been built up close to the main retaining wall and between it and the boiler-house. This is shown in the section we give in Fig. 6, but only in outline.



CASE 2 — BUNKERS EMPTY.

Fig. 5—STRESS DIAGRAM

In Figs. 4 and 5 are given the stress diagrams showing the distribution of the forces acting upon the wall, in the one case with the bunkers full, and in the other case with the bunkers empty, the two conditions making a very different distribution on the base, as shown. The elements entering into the problem will be noted from this diagram, and it will be sufficient indication of the manner in which the forces very close down on to the top of the sewer, especially in those parts where the floor of the bunker was inclined towards the boiler-house. It is intended to fill up with earth on the railway-side right up to the top of the wall. The wall was buttressed from end to end for the sake

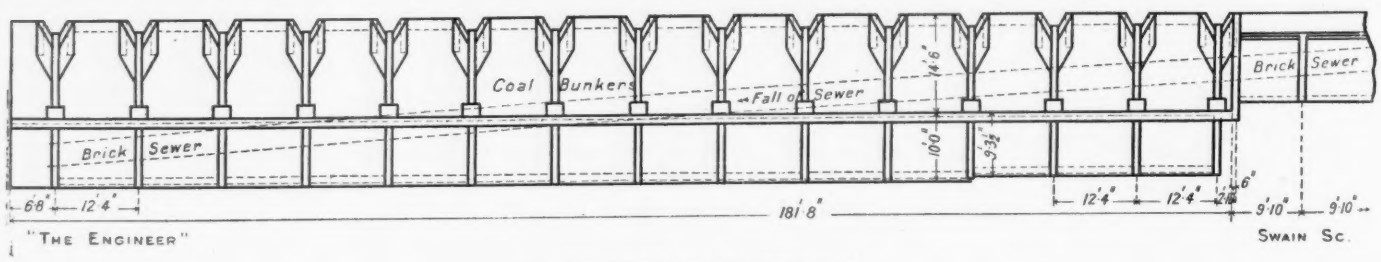
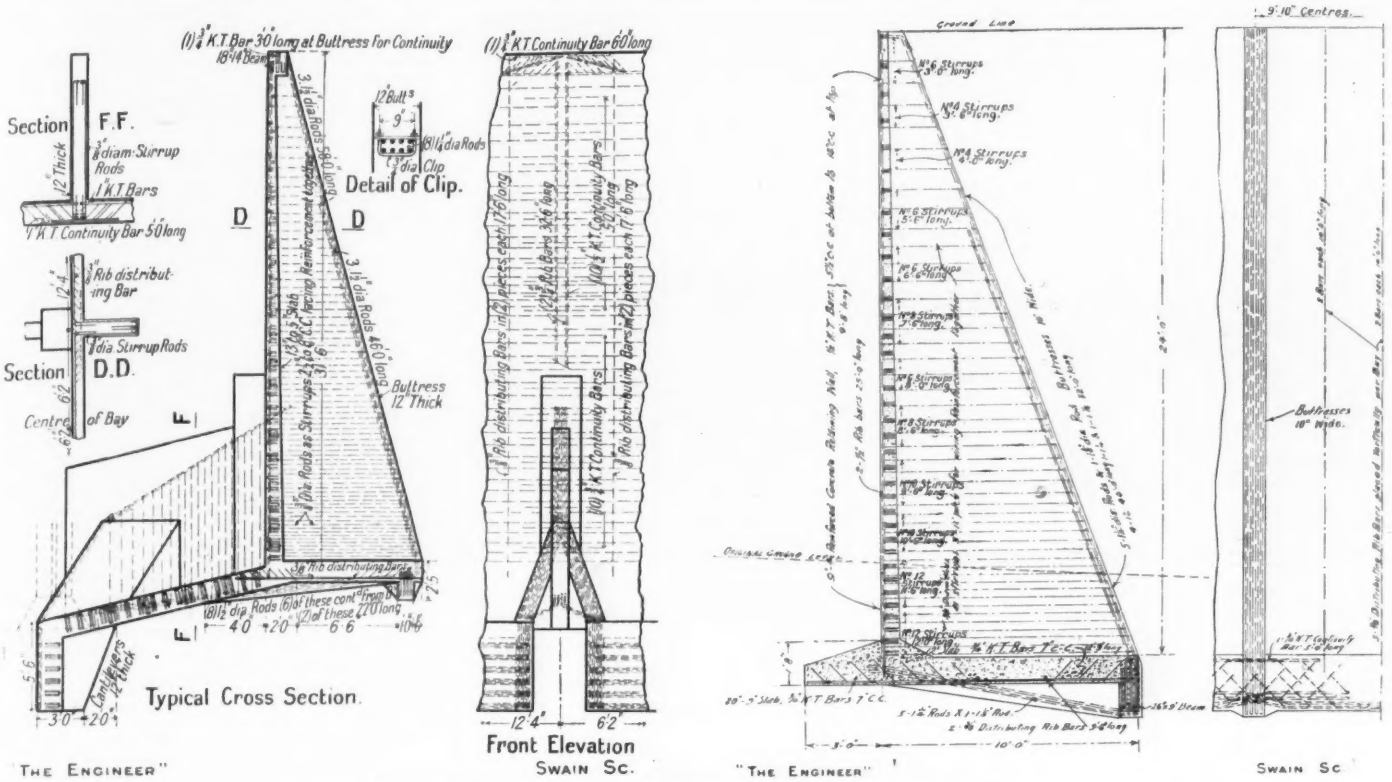


Fig. 2—PLAN OF THE RETAINING WALL

were determined to say that the calculations were based on the usual wedge theory assumption of the thrust of the earth, the actual height being increased proportionately to the overload imposed by the traffic of the main London and North-Western line. The work was designed and supervised by

company complained of the tyrannical conduct of Mr. J. V. Gooch (an elder brother of Sir Daniel Gooch) within a few weeks of his appointment as locomotive superintendent. The Eastern Counties line was then a by-word for danger, delay, unpunctuality, and general inefficiency. Stratford was in a

labour, and on the same date 1000 enginemen of the North-Eastern Railway sent in their notices to cease work on April 20th. The demands of the Brighton Company's locomotive staff were for a limitation of daily work either by mileage (150 miles) or time (10 hours), and the abolition of a gradu-



Figs. 6 and 7—DETAILS OF THE REINFORCEMENT OF THE RETAINING WALL

the Trussed Concrete Steel Company, Caxton House, Westminster, S.W., in accordance with the general requirements of the engineer of the County Borough of Bury, the reinforcement being on the Kahn system.

EARLY RAILWAY UNREST.

SOME interesting tables of disputes causing stoppage of work directly affecting railway servants from the beginning of the year 1889 to August, 1911, were handed in to the Royal Commission on the Railway Conciliation Board Scheme of 1907 by the assistant secretary to the railway department of the Board of Trade in the course of the evidence given by him. These tables are remarkable as revealing what a comparatively small number of labour disturbances have occurred in this vast industry during the last twenty-three years, and in what very trivial grievances most of the strikes which actually took place had their origin. It will be interesting to carry the investigation further back so as to trace the evolution of railway unrest down to the period covered by the above report.

So long as the railway system was in its infancy there was only one section of railway workers which was in a position to bring pressure to bear upon the directors to consider its grievances. This section represented the most skilled men, namely, the drivers and firemen. However, in the earliest days of all, when lines were very short and trains very few in number, it was possible for the management to circumvent even dissatisfied enginemen. For instance, soon after the opening of the Eastern Counties Railway between Shoreditch and Colchester, the enginemen struck in a body. Mr. John Braithwaite, locomotive superintendent at the time, turned out the same morning with certain gentlemen apprentices and a few fitters, and worked his traffic as though nothing had happened.

It was not long, however, before the altered conditions of traffic precluded such a simple solution of a similar difficulty. In the late "forties" we find the engine-drivers not only well organised, but constituting a kind of freemasonry. As fixed signals were still somewhat of a rarity, we are told that these men had a code of private signals amongst themselves, which, so they claimed, enabled them at all times to tell the state of the line, and to run their trains at any speed with the greatest safety. Posing as the champions of public security, they were disposed to interfere in the appointment of locomotive superintendents.

The first serious railway strike was one of drivers, and it occurred on the London and North-Western Railway in 1848, in consequence of the appointment of Mr. McConnell to supersede Mr. Edward Bury in the above capacity. The charges made by the "old drivers" against the former gentleman very much confined themselves to those of a personal character. Mr. McConnell came to the North-Western from the Birmingham and Gloucester Railway, where, it was alleged, he had engaged such incompetent enginemen that many fatal accidents had resulted. Incidentally also he was accused of cutting down wages. Protests were entered against Mr. McConnell's newly imported drivers on the southern division of the North-Western system on the plea of the inefficient and dangerous working of the line under these men, who were accused of running past signals and of being under the influence of liquor whilst on duty. The agitation culminated in 240 "old drivers" striking. The tact of the chairman, Mr. Glyn, however, brought about a settlement. Guarantees were given that wages should not be lowered, and all the strikers were reinstated, while the services of the new men were retained, but only in a subordinate capacity.

Two years later a somewhat similar dispute arose on the Eastern Counties Railway. The drivers and firemen of this state of insubordination. Mr. Gooch was engaged to introduce effective discipline. But the enginemen, never having been convicted or even accused of insubordination until the new broom began to sweep, should have had some detailed notice of the change in discipline about to be made. Instead of this, they were permitted to see but one, and the worst, part of the new system, viz., the introduction of an arbitrary code of fines, enforced even in the case of accidents due to defects over which the men had no control. Gooch was accused of taking a low salary, together with high percentage on what he could save the company, and thus of endeavouring to enrich the latter by mulcting the men of their earnings. His summary removal was demanded by the drivers and firemen, but the directors refused to comply after hearing the locomotive superintendent on his defence. The enginemen then resigned in a body.

The result was chaos, and at the busiest season of the year, viz., August. Eventually, nearly all the main line trains had to be taken off, and two branch lines shut up, while the suburban traffic was annihilated. A Woolwich train stuck on the incline at Stratford Junction, and passengers had to get out and push it up. The old coach road between Colchester and London came to life again. In one week there were counted on this highway 32 stage coaches, 126 fish vans, 411 carriers' wagons, 3271 beasts, 7446 sheep, and 453 pigs, all which represented traffic diverted from the railway. The great Romford brewers, Ind and Coope, withdrew their traffic and returned to the road. The strikers are said to have behaved very well, and to have been guiltless of acts of intimidation. Nevertheless, we read of metropolitan police at each station, and the engagement of "dry-nurses," so-called, to ride on the foot-plate to protect the new hands. At the end of the month, when all the best engines were reported derailed or otherwise *hors de combat*, the company gave in on most points, notably on the question of fines. Mr. Gooch's services were, however, retained, and by his reforms he ultimately succeeded in saving the company from £20,000 to £30,000 a year.

The strikes on the North-Western and Eastern Counties were considered at the time a great novelty in trade disputes. They testify to the great demand for drivers and consequent difficulty in procuring an adequate supply of sufficiently reliable men at that period. A very different state of affairs prevailed, however, where less skilled railway labour was concerned, and on one or two occasions the companies quashed incipient agitations on the part of porters, goods clerks, &c., in drastic fashion. For example, in November, 1845, the London and South-Western porters at Nine Elms prepared a respectfully worded petition asking for a more equalised time of labour—to work eighteen hours a day was common—or an increase of wages. No answer was vouchsafed, but a clerk went down by an express engine to all stations to Southampton with an agreement for every porter on the line to sign, requiring them to remain at the wages now given, and not to leave without a month's notice. The country men were led to believe that the London men had already signed the agreement. The Nine Elms staff was then asked to sign, and on its refusing to do so it was instantly dismissed, and its places filled up by men brought from the country.

There were no serious labour troubles in the railway world for a long period following the Eastern Counties strike. Even the autumn of 1859, when strikes were rampant in all other trades and the trade unions much to the fore, passed off quietly on the railways. In the winter of 1866-7 great unrest among enginemen all over the country began to manifest itself. Eventually 13,000 men joined the movement, and their threat of a general strike created widespread consternation, for it was realised that it lay within their power to arrest nearly all the operations of trade and commerce. The trouble came to a head on the Brighton line on March 25th, 1867, when the drivers and firemen withdrew their

ated scale of wages—all to be paid the maximum after a few months' service without reference to ability. The directors resisted these demands, and made much of the fact that they had already established a superannuation fund, being the first company to do so.

Public sympathy was with the men on the first demand, for the hardships involved by spending ten hours outside an engine, with no cab or weather board, in such terribly severe weather as had just at that time been experienced, appealed to everybody. Mr. Craven, the locomotive superintendent, succeeded in mustering forty or so extemporised drivers and firemen, and so worked the main line after a fashion with monster trains, dispatched at long intervals, and travelling in no case at more than 20 miles an hour, while platelayers were stationed all along the line, as in foggy weather. Some of the branch lines were entirely closed, and the remainder were worked by horses. Never since the great cab strike of 1853 had such great and sudden inconvenience been caused the public. The Epsom spring meeting opened, and found traffic entirely suspended in that direction.

Mutual concessions ended the strike, after it had lasted two days, the men's grievances about the long hours and slow promotion being redressed. Meantime the agitation of the North-Eastern enginemen had come to include requirements which involved serious questions of discipline, as well as the usual demand for higher wages and shorter hours. The men, we have seen, originally gave the month's notice required in conformity with the terms of their engagement. Later they withdrew these notices, and began a surprise strike on April 11th at Darlington. In fourteen days the traffic of the line was in full operation again, but not by the wholesale return of the 1500 men affected to their work. The places of the majority of the strikers were filled up. The result was described as the first decisive check suffered by trade unions in recent times.

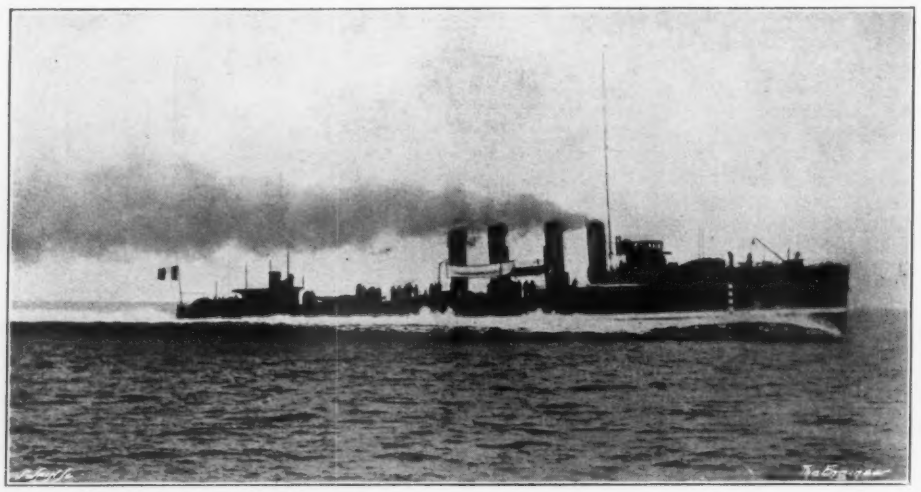
A strike of the Midland Company's goods guards occurred in January, 1879. The reasons given were the reduction of the pay of guards receiving 17s. a week to 16s. a week and the increase of time from 60 to 66 hours a week. Public opinion sided with the men, for the company's motive for economy at a time when it was showing progress was not held to be justified. Great disorganisation of traffic ensued, and round Leeds the working of the block system was suspended; but elsewhere the signalmen declined to use their power to make the strike a success. The men gave in when somewhat better terms were offered them, but the victory cost the company its popularity with the public for a time.

The strike on the Caledonian Railway in January, 1883, which began as a local agitation in and near Glasgow, and ended by paralysing the Hamilton coal trade, is memorable for the fact that it witnessed the first appearance of the Amalgamated Society of Railway Servants, which at once made its own recognition a crucial point. A compromise on the questions of pay and hours ended this dispute.

Lastly, there was the great strike of 2713 Midland enginemen, which began on August 5th, 1887, but fizzled out at an early stage. The public was not in sympathy with the strikers. The new rules deemed necessary by the officers of the company, which led to the strike, entailed no other hardship than a possible small variation of earnings, while the saving to the company by the new system, which was to ensure efficiency and strengthen discipline, would be only £940 out of an outlay of £342,000 per annum. According to the chairman, 2352 out of a staff of 3187 either did not join the strike or soon returned to their duty, and 588 new appointments were made. Men who left their trains on the line were successfully prosecuted and condemned in penalties. The Board of Trade took a new departure on this occasion, sending an open letter to the company expressing a hope that every precaution had been taken for the safety of the travelling public.

THE FRENCH DESTROYER BOUCLIER

A. NORMAND AND CO., LE HAVRE, BUILDERS



THE FRENCH DESTROYER BOUCLIER.

THE French destroyer Bouclier was recently handed over to the French Admiralty by the firm of A. Normand and Co., which built her. This vessel is the first among the numerous craft built at the Normand Yard to be fitted with Normand boilers fired only with liquid fuel. The burners employed are of a type patented by the firm. The Bouclier, which was engined by the Cie. Electro Mécanique, of Le Bourget, near Paris, has the following particulars :—

Length over all	233ft. 4in.
Length between perpendiculars	23 ft. 4in.
Extreme breadth outside plating	24ft. 10in.
Depth	16ft. 5in.
Mean draught	12ft. 6in.
Displacement on trials	660.44 tons.

The hull is of high tensile steel, galvanised in the upper works. It is divided into ten water-tight compartments. The hull is clincher riveted, the stem is of forged steel, and the sternpost, &c., of cast steel. The vessel is divided as follows :—From forward aft : Collision compartment, crew's quarters with chain locker underneath, ammunition room and store-room, boiler-rooms, engine-rooms, officers' quarters, petty officers' quarters, and store-room. The deck is covered with linoleum and wooden battens.

The Bouclier has a high freeboard forward, and owing to this the men are better berthed than in other French destroyers, while the vessel is able to maintain a good speed even in a rough sea. The navigating officer and the man at the wheel are also better protected than is the case in previous boats.

Steam is supplied to the main engines and auxiliaries by four Normand water-tube boilers. The liquid fuel is, before being used, heated in a form of heater which has been newly patented by the Normand firm. The boilers have a heating surface of 5277 square feet and a combustion chamber of 386 cubic feet capacity. The safety valves are set at 228 lb. per square inch, and at full power an air pressure equal to that of 110 mm.—about 4in. of water—is permitted in the stoke-hold. The boilers have been designed each to burn 3300 kilos. (= 7273 lb. of fuel) per hour. but as a matter of fact this consumption was not reached during the trials even at full power when the speed attained was actually about 4½ knots in excess of that contracted for.

The main engines consist of Parsons turbines driving three shafts. There are a high-pressure ahead turbine on the centre shaft and two low-pressure ahead turbines on the wing shafts. Astern turbines are incorporated in the casings of the two latter turbines. Each shaft carries one propeller, 5ft. 3in. in diameter and 4ft. 11in. pitch, designed to work at 1000 revolutions per minute at full power. The condensers have a cooling surface of 11,682 square feet, and a vacuum of 700 mm. was guaranteed. The four Normand boilers have a heating surface of 21,108 square feet, and the cubic capacity of the furnaces is 1544 cubic feet. Each boiler has nine burners.

The following are the results of the official trials :—

Six Hours' Full-power Trial.

Displacement at start	650.44 tons
Average mean steam pressure	217 lb.
,, ,, ,, chest pressure	183 lb.
,, air pressure in stokeholds	109 mm.
Pressure in liquid fuel burners	143 lb. per square inch
Revolutions per minute, mean	1034.2
Mean speed for six hours	35.334 knots
Contract speed	31.0 ,,
Shaft horse-power	15,000
Vacuum at condenser	700 mm.
Consumption of fuel per hour	21,912 lb.
,, permitted by contract	29,193 lb.
,, per square foot of heating surface	1.038 lb.
,, per horse-power hour	1.46 lb.

Eight Hours' Consumption Trial.

Displacement before trials	659.446 tons
Mean draught	1 .6ft.
,, steam pressure at boilers	2 4 lb.
Revolutions per minute, mean	325.19
Mean speed for eight hours	14.06
,, ,, as per contract	14.00
Shaft horse-power	1400
Vacuum at condensers	730.3 mm.
Consumption of fuel per hour	1915 lb.
,, ,, per horse-power hour	1.37 lb. (nearly)

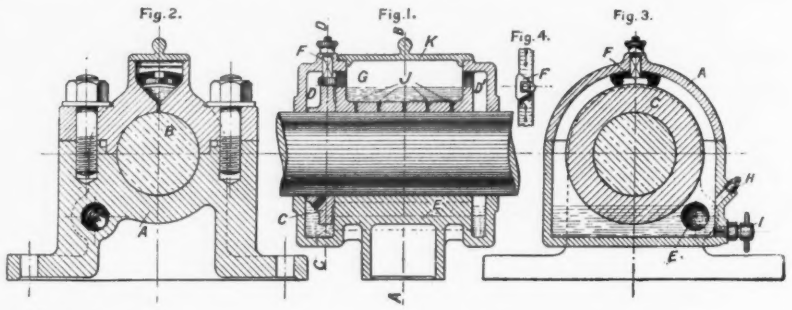
The shaft horse-power was ascertained by means of a Hopkinson-Tring tortiometer.

The Bouclier has up to the time of writing proved herself to be the speediest and most economical vessel of her class, and her performances are certainly excellent. Her armament consists of four 18in. torpedo tubes. Six torpedoes are carried. There are two 4in. quick-firing guns, one forward and one aft, and two 2.5 quick-firers, two forward and two aft, one on each side. Four hundred and fifty shells are provided for each gun.

The fuel bunker capacity is of such dimensions that the fuel which can be carried permits of a radius of action at 14 knots of 1950 miles. A view of the vessel under weigh is given herewith.

AUTOMATIC LUBRICATOR FOR SHAFTS.

AN improved method of oiling the bearings of suspension hangers, wall brackets, &c., is being introduced by Geo. Richards and Co., Limited, Broadheath, Manchester. In the annexed sectional views—Figs. 1, 2, 3 and 4—A is the cast iron bearing, B the shaft, C a revolving collar which can be made in halves for picking up oil, D and D¹ end chambers to collect the oil from the bearing, E a passage to connect



AUTOMATIC SHAFT LUBRICATOR

the end chambers, F an adjustable oil wiper, G a receptacle for the oil, H a hole through which the lubricant is supplied, I a screwed plug for running off the spent oil, J a series of holes to distribute the oil evenly over the bearing, and K a loose cover. The chief features of the bearing are the collar C and the wiper F. The collar is fixed to the shaft, and in rotating becomes smeared with oil, which is wiped off by the adjustable wiper F into the top channel G. It will be observed from Fig. 4 that the wiper is V-shaped in plan. It acts equally well with the shaft revolving in either direction. The flow of oil is easily regulated by altering the pressure of the wiper by means of the screw shown. A further advantage claimed for the appliance is that when the shaft is stopped the oil in the top chamber can percolate through the bearing and thus ensure a good supply of lubricant on starting up.

PRODUCER GAS.

AS most of our readers are aware, the greatest trouble which is met with in the use of producer or blast-furnace gas in gas engines is the difficulty of removing from it the tar and dust, both of which give rise to trouble if they enter the engine. Tar is the more troublesome to get rid of, because when it leaves the producer it is in the form of vapour. How necessary its removal becomes is shown by the demand of many engine builders that the purification plant should have an efficiency of 99 5 per cent. An analysis of the gas before cleansing will generally show 10 to 12 grammes of tar per cubic metre, 3 to 5 grammes of heavy dust per cubic metre, and 9 to 11 grammes of soot. There are two methods in use for cleansing the gas—the dry or atmospheric method, and the wet or water-cooled method. In the former the whole of the cooling and the removal of dust are carried out without bringing the gas into contact with water, whilst the tar is abstracted in an apparatus of the Livesey or Pelouse and Adouin pattern. In the latter method the dust is removed, together with some tar, by means of a very fine water spray, whilst the bulk of the tar is removed by centrifugal extractor fed with water. The final traces of tar in both cases are eliminated by passing the gas through sawdust scrubbers. In the dry method the gas on leaving the producer is usually passed through a large box fitted with a number of baffles so spaced as to make the gas alternately fill a comparatively large and then a smaller volume. In this way most of the heavy and some of the lighter dust is deposited. Passing from the dust-catcher the gas passes through tubular atmospheric coolers, which are sometimes annular in section to give large surface; and it is in the first and second of these coolers that the deposit of tar and dust usually occurs. This deposit renders the type unsuitable for continuous running over long periods. Leaving the atmospheric coolers, in which the temperature has been reduced to within two or three degrees Centigrade of the surrounding air, the gas passes to a Livesey washer, where it is broken up into very fine bubbles and passed through about 3in. of water, and thence to the sawdust scrubbers.

In the atmospheric towers approximately 30 per cent. of the tar is taken out by plain condensation, while the washer accounts for a further 85 per cent., leaving the remainder to be extracted in the sawdust scrubbers. In a paper on "Producer Gas" read before the Manchester Association of Engineers on December 8th last Mr. J. A. Weil represented the process of purification as follows :—

					Per cent. of total extracted.
Leaving	producers	10.0	grammes per cubic metre	=	0.0
,,	coolers	7.0	,, ,, ,,	=	30
,,	Livesey washer	1.05	,, ,, ,,	=	59.5
,,	sawdust scrubber	0.05	,, ,, ,,	=	1.1

By not bringing the gas into contact with water in the process of cooling it is claimed that no "tar fog" is produced with this type of plant, with the result that the tar is more easily extracted than with the water-cooled type. The author of the paper does not agree with this process of reasoning since even if all the steam admitted to the producer be decomposed therein, there is still moisture in the coal which, together with that due to destructive distillation, causes the gas to have a dew point of from 25 deg. Cent. upwards. Hence since the gas must always be cooled to this temperature or lower, condensed water is just as likely to form a skin round the floating tar particles as in the water-cooled type.

In the water-cooled type of apparatus the gas is usually passed direct into a water-spraying device such as the Mond washer. In this apparatus the intensive mechanical action of the falling water spray causes all the dust to settle out. Another form of apparatus in vogue consists of a cylindrical tower with vertical baffles down the spaces between which atomised sprays of water are caused to play. In both these forms of apparatus a preliminary cooling is carried out simultaneously with the extraction of dust and tar. Passing from the wet dust separator the gas goes either direct or through a coke-filled wet cooling tower to the centrifugal cleaners. In the latter the churning action causes the bubbles of tar fog to be broken and deposited on the sides of the casing. Water sprays are placed in these machines, and assist in both the further cooling of the gas and the removal of the tar.

Mr. Weil gave the following figures relating to a 1000 horse-power water-cooled type of cleaning plant consisting of a Mond washer, two centrifugal cleaners in series, and two sawdust scrubbers in parallel :—

Fuel gasified per hour	8.34 cwt.	
Temperature of gas entering—		
Mond washer	over 400 deg.	Cent.
No 1 cleaner	49	,,
No. 2 ,,	32	,,
Sawdust scrubber	14	,,
Cooling water	8	,,
Atmosphere	10	,,
Pressure of gas entering—		
Mond washer		
No. 1 cleaner	15.5 c.m.	water gauge
No. 2 ,,	23.5 ,,	,,
Sawdust scrubber	24 ,,	,,
Grammes of tar per cubic metre in gas leaving—		
Producer	11.68 = 0.0	per cent. extracted
Mond washer	4.30 = 62.9	,, ,,
No. 1 cleaner	1.55 = 22.8	,, ,,
No. 2 ,,	0.30 = 10.8	,, ,,
Sawdust scrubber	0.04 = 2.2	,, ,,

No. 1 cleaner, which was also blowing gas, thus extracted 60.4 per cent. of the tar in the gas with which it was fed; and No. 2 cleaner, running in the reverse direction to No. 1, extracted 80.6 per cent. of tar in the gas with which it was fed. The combined extractive effect of the two in series was therefore 90.7 per cent.

From the preceding figures it will be seen that with the atmospheric type of plant the sawdust scrubbers have to extract about 10 per cent. of the tar made, while in the water-cooled type they have only to extract 2.2 per cent. of the tar. It follows that the life of the packing of these filters will be much longer with the latter than with the former type. Mr. Weil suggests that perhaps the best form of plant would be a combination of the two types, in which the Livesey washer of the atmospheric plant would be replaced by the centrifugal cleaners of the water-cooled type. This is confirmed by the fact that the centrifugal cleaners work best with cold gas at the suction inlet.

THE extension of wireless telegraphy in India is now to be carried out systematically. A route from Calcutta to Jutogh, Simla, by way of Allahabad and Delhi, was chosen in the first instance, and the installations are nearing completion. The next station to the north will be at Lahore, and this will be put in touch with Karachi. Later on Peshawar will doubtless be included in the system. In the west an installation is to be given to Bombay and another to Nagpur. Necessary funds will be provided next year.

THE FUTURE OF RAILWAY ELECTRIFICATION.

THE following is an abstract of a paper read by Mr. Philip Dawson at the Royal Automobile Club on Friday, December 8th.

There are at the present only two tried electric railway systems generally under discussion, namely, the so-called continuous current, or what in America is called the direct-current, and the single-phase alternating-current system.

In order to reduce the very heavy currents necessitated by heavy railway traction, some engineers advocate the use of 1200-volt continuous current; but such a pressure must necessarily seriously increase the costs of the third rail, even if third-rail constructions with 1200 volts can be tolerated in this country, as contact with 1200 volts continuous current is generally followed by fatal consequences.

It has even been proposed by some that the working pressure for continuous current should be raised to 2000 or even 3000 volts, but this would necessitate the use of overhead conductors, as well as many complications in the motor and controller equipments. It need not, therefore, be considered here.

The other system which has so far been successfully installed both on the Continent of Europe and in the United States is the single-phase system, and it is this which has been employed on the electrification carried out on the London, Brighton and South Coast Railway.

Practically all engineers who have given the matter serious attention are apparently agreed that for anything except purely urban work with a very frequent train service and many stops, the only system which can be economically installed to deal with long distance or goods traffic is the single-phase alternating current.

The exponents of the continuous-current system contend that, for urban and suburban traffic, the continuous-current system is the cheapest to install and operate, and that, if any further extensions were to be found advisable, the single-phase system could easily be installed, in addition to the continuous-current system, thus rendering the duplication of plant a certainty in the event of electrification proving financially desirable for anything beyond purely urban working. On the other hand, those who have had experience of the single-phase as well as the continuous-current system, both here and abroad, contend that the single-phase system will be found, from an economical point of view, at least as satisfactory for suburban working as the continuous-current system, whilst it is the only one which lends itself to unlimited extension.

The choice as to which system to install will largely depend on whether railway authorities are prepared to neglect all future requirements and possibility of extensions, and select a system which is not elastic, and which, should extensions ever prove desirable, would necessitate the instalment of a dual system.

But there is a further important question to be considered, and that is the absolute necessity for railways electrifying their lines considering the question of uniformity of system, so as to allow interchange in traffic, which has proved such a fruitful source of blessing to the travelling public in the past. This might be an argument in favour of the continuous current, had any electrification on a very large scale taken place on any of our main line railways. Fortunately, this is not the case, and there is still the possibility of railways agreeing on the use of one uniform system, if and when they electrify. The cost of the battle of the gauges and the battle of the compressed air and vacuum brakes is an example which, it is hoped, will not be repeated in the case of railway electrification.

The first to venture on electrification on a large scale were the United States of America, and it is in consequence of this that a very large proportion of electrified lines in this country are equipped with apparatus of American origin. The great development of the tramways in the United States, and the absence of roads, soon led to the building of so-called inter-urban lines, running over the ordinary tramway routes in the cities through which they passed at reduced speeds, whilst in the open country they ran on their own right-of-way and frequently at very high rates of speed. It was for this class of work that the single-phase system was first largely developed in America, but its adoption under these conditions necessitated the installation of a complicated system and unsatisfactory motor, which, while in the cities it ran over 500 or 600 volts continuous current lines, could in the open country run on single-phase lines with 6000 to 11,000 volts pressure. It is not surprising that under these conditions the single-phase system has frequently proved unsatisfactory, yet it is this arrangement which is advocated by many engineers who are in favour of the dual system.

The first American main line to adopt electric haulage was the Baltimore and Ohio Railroad, who electrified the tunnel under the city of Baltimore in 1895, and has 9 miles of electrified track and owns five goods and three passenger locomotives. The first railway to electrify in consequence of tramway competition was the Long Island Railroad, which is owned by the Pennsylvania Railroad. This line was opened in 1905, and is entirely operated by multiple unit trains. Its financial results have been satisfactory; it has 110 miles of track equipped.

The next equipment was carried out by the Pennsylvania Company, who electrified a line connecting Philadelphia and Atlantic City on the sea coast. This line is called the West Jersey and Seashore line. Goods trains are still run over it by steam, and the train service is not a very frequent one; the distances between the stops are considerable. The distance by this line from Philadelphia to Atlantic City is 65 miles, and there are 162.7 miles of single track electrically equipped.

One of the most important electrifications is that of the N.Y.C. and H.R.R. The immediate reason for electrification was the difficulty of properly ventilating the long tunnel which leads into the New York terminus, and, as a result, traffic of every kind is handled purely electrically.

At the end of the electrified section steam locomotives are hitched on and take the place of the electric locomotives. There are at present 22.5 miles of route equipped, comprising 101 miles of single track and 47 electric locomotives; 125 motor cars and 55 trailers are in use.

The next line of importance to be opened for electric traction in 1907 was the New York end of the N.Y.N.H. and H.R.R.

The importance of this electrification lies in the fact that this company adopted the single-phase alternating-current system. The experience they have now had for the last four years has turned out so satisfactory that they are electrifying all their large goods yards in New York, as well as the remainder of their New York suburban system. Their electrification in all amounts to 300 miles of single track, and they operate a number of multiple unit trains and own 77 electric passenger, as well as 15 electric shunting, locomotives. Their express trains reach speeds up to 80 miles an hour.

A new line—the Spokan and Inland Railway, electrically equipped on the single-phase system in 1907—operates by means of electric locomotives on grades of 1:50. The line is 135 miles long, and 9 electric locomotives and 24 motor cars operate over it.

The Grand Trunk Railway have electrified their tunnel under the Detroit River on the single-phase system, and there are five electric locomotives to do the work.

The Michigan Central have electrified their tunnel between Windsor, Ontario, and Detroit, Michigan.

The Southern Pacific Company, in 1909, converted a section of their local lines in and round San Francisco to 1200 volts continuous-current traction, with an overhead conductor. They are running forty-four motors and forty trailer coaches.

Last, but not least, is the electrification of the New York Terminal Station of the Pennsylvania Railroad, on which 160,000,000 dols. have just been expended. The total length of single tunnel of this line is 15.54 miles, and the total electrified track amounts to 107.8 miles of single track.

The main reason for the adoption of the continuous-current system for this installation was the necessity for inter-working with the very large existing Long Island system. The latest electrical equipment is that of the Hoosac tunnel line, which belongs to the N.Y.N.H. and H. Railroad, and which has just been completed on the single-phase system.

Having thus briefly shown the very large extent to which electric traction has already been adopted by American main line railways, we will consider the progress made so far in Europe.

With their characteristic thoroughness, the Prussian Government went to work and spent a large amount of money in order to discover what, if any, benefits they could derive in electrifying any portion of their railways.

With a view to testing the benefits which might result from electric traction, they electrified the Berlin Gross Lichterfelde section of the Berlin suburban system on the continuous third rail system between Berlin and Gross Lichterfelde, a distance of eight miles, on which there is a very heavy local service. This line was opened in 1903, and has been giving very good results ever since. The studies which the Government engineers made, and the very complete data which they collected in the course of several "Studienreisen" in the United States, soon convinced them that electrification would, in the near future, be applied to a much larger field than the purely suburban one; but to render any such extensions economically possible it was necessary to consider very high working, as well as transmission pressures, which was quite out of the question with continuous current.

It was just at this time that electrical engineers in Europe and America had realised this necessity and had developed a satisfactory single-phase traction motor which, if found to be commercially successful, would fulfil all requirements.

The Prussian Government, with the object of testing this invention, installed the single-phase system on a local line in the suburbs of Berlin, near Spindlersfeld. The results of the experiments, extending over nearly three years, were so satisfactory that the Prussian Government adopted this system for electrifying the suburban line in Hamburg. This is a purely local service, and the figures of capital expenditure and working costs there obtained have enabled the Government to make a comparison between continuous and alternating current operating under similar conditions of heavy suburban service.

The Hamburg system owns 110 motor cars, as well as many trailer coaches. The Hamburg system has now been running for over four years, and has given the Prussian Government the greatest satisfaction in every way; so much so that the chief engineer of the Prussian Government Railways, Herr Wittfeld, in a letter to me, stated that "the Prussian Government were definitely satisfied now that for handling purely suburban traffic, the single phase was, from every point of view, at least as satisfactory as the continuous current system." Having come to this conclusion, after further thorough investigation, the Government made up their mind that great economy in operating main lines might be gained by substituting electric for steam haulage, and that the saving thus effected would be so large as to pay a handsome profit on the capital required for electrification.

With a view to proving the accuracy of these conclusions, they decided to electrify the section of main line between Magdeburg, Leipzig and Halle—a distance of over 100 miles.

In addition to this line, over which there is a very intense service of passenger and goods trains, the Prussian Government are also electrifying a single line of railway over which there is a moderate traffic of passengers and goods. This line is situated on the borders of Saxony and Bohemia, and extends from Laubach, Dittersbach, Konigszelt, Hirschberg, Landshut, Rubank, Lidan, Niedersalzbunn, and Halbstadt, representing a total length of over 175 miles. In addition to the work carried out by the Prussian railway authorities, the Grand Duchy of Baden has electrified a section of railway, the Wiesenthal line between Basel, Schopfheim and Zell—a total distance of a little more than 31 miles of route—the line being operated by single-phase locomotives.

The very satisfactory results obtained with the single-phase system in Hamburg, and the very wide field to which electrification will undoubtedly be applied in the near future, have resulted in all the German Government railways deciding henceforth only to consider the single-phase system of electrification, so as to have uniformity of railway electrification for all purposes.

The first result of the satisfactory operation at Hamburg has been the decision to electrify the whole of the Berlin Stadtbahn, at a cost of £10,000,000.

In Austria, the Government railway authorities have also investigated the question of railway electrification, and both continuous and single-phase examples are working there, so that comparisons are easy to make. As a result, the Austrians have also decided to consider nothing but single-phase, although in their case at present only heavy, long-distance work is under consideration. They are electrifying the Mittenwald Railway which joins Innsbruck with Patenkirchen, and electric locomotives will be used to haul the trains. A new line between Vienna and Pressburg is also being equipped on the single-phase system.

In Switzerland, conditions are somewhat special, as large water powers are available. There also the whole question has been investigated by a Government Commission, who have recently decided in favour of the single-phase system.

The new Lötschberg line, which connects Berne with Brieg and the Simplon, will be worked by large single-phase locomotives.

Italy has two railway electrifications, which have been running successfully for many years; one is between Milan, Varese, and the Lake of Lugano, and the other is between Lecco and Sondrio. A new line between Genoa and Giovi, the mountain section on the Milan-Genoa line, has just been opened for electric traction. The Milan-Varese line is continuous current, whilst the two latter are three-phase lines.

The Swedish Government have for many years contemplated railway electrification, and, after many experiments, they have adopted the single-phase system for the line within the arctic circle they are electrifying between Kiruna and Riksgransen, over which there is a very heavy mineral traffic.

Holland has its single-phase line between Rotterdam and The Hague, and France, after some years of quiescence, is electrifying on a great scale in the South. The Midi Railway Company have definitely decided to electrify a large portion of their lines in the neighbourhood of Toulouse, as regards both its local lines and some of its long distance lines. This company have, after the most careful study of the results obtained elsewhere, decided on the single-phase system as the only one which answers the general requirements of a large railway system dealing with all kinds of traffic. The section at present being electrified is equivalent to 175 miles of single track. The motor cars for the multiple unit trains have already been ordered, and several powerful locomotives, rated at 2000 horse-power each, have been ordered from various firms.

Besides this modern electrification, there exists the electrification of the Quai d'Orsay terminal of the Orleans Railway in Paris, and the electrification of the lines from Invalides station to Versailles on the western line. Both of these were carried out and completed before the birth of the single-phase system; the former in consequence of steam haulage not being permitted at the Quay d'Orsay by the French Government, and the latter to try electrification of a short suburban line. In both cases satisfactory results have been obtained.

Here Mr. Dawson deals with electrified portions of main lines in this country. The last application dealt with is that for which he was responsible, namely, the electrification of a portion of the suburban system of the London, Brighton, and South Coast Railway Company.

The total amount at present electrified is equivalent to 62 miles of single track, and fifty electric motor coaches are possessed or are on order. The financial results have so far proved satisfactory. In considering any electrification of the Brighton Railway, the fact cannot be overlooked that Brighton is under 51 miles from Victoria, and that the service over this line is already very intense. Thus, between London and Wivelsfield there are sixty trains a day each way, whilst at present there are about forty trains a day each way between London and Brighton. The termini in London and at Brighton are already so congested that an increase in the train service without very considerable enlargements—some of which are nearly impossible to carry out—is quite out of the question. Hence, as early as 1903, when I was first instructed to consider the question of electrifying a small portion of the suburban service, the fact that it was quite conceivable that electrification as far as Brighton might be necessary in the near future could not be left out of consideration.

This was one reason, in addition to many others, why the third-rail system was quite out of the question. At that time it was practically admitted that if only suburban service had to be considered, the continuous-current third-rail system was then considered the better of the two.

On the South London line, experience extending over two years has shown that this is not the case, and that the results, as regards economy of working, are, if anything, better with the single-phase than with the continuous-current system. The results so far obtained have been so encouraging that extensions from Balham, *vid* Thornton Heath, to Croydon and Wallington and other adjoining lines are being planned.

The whole case of long-distance electrification rests on cheap electric power being available, and the cost of distribution being kept within moderate limits.

In England to-day electricity for traction purposes is being generated by steam at a works cost of ¼d. per unit; on to this must be added the capital charges, which will vary according to the nature and size of the power plant and its location and load factor. In America works cost is as low 0.22d. per unit in a station which consumes 2.9 lb. of coal per kilowatt-hour. Capital charges should not exceed 0.2d., so that it is quite conceivable that railways will in the future be able to purchase alternating current in this country at 0.4d. to 0.45d. per unit, delivered to them on their railway, and this will be the total cost to the company if alternating current is used. On the other hand, if continuous current is adopted, this figure will be increased by the losses sustained in the course of transformation, and by the low-pressure distributing losses, as well as by the costs involved in the sub-stations as regards working, maintenance, and capital charges. Some idea of what these may amount to may be gained from the fact that in the case of the N.Y.C. and N.H.R.R., according to Mr. Wilgus, the cost of sub-station transformation and distribution is 0.158d. per unit, whilst the capital charges due to this item are 0.455d., thus making a total of 0.613d. per unit for transformation alone, a truly colossal amount. This need not be so great in every case, but, under such favourable conditions as exist in London on the County Council tramways, this figure is represented by 0.26d., or a figure larger than the total works cost at the generating station. This would increase the cost of current to the railway by at least 50 per cent., making the cost of continuous current delivered to the line 0.6d. to 0.675d. per unit. This is a very important consideration when it is remembered that the cost of current represents about 50 to 60 per cent. of the total locomotive charges per train mile.

With cheap electricity and a frequent train service, which enables the interest on the capital expended on the conductor system to be divided over a very large train mileage, electric traction becomes cheaper than steam, in addition to the numerous other advantages which it possesses.

The annual cost for maintenance and repairs of electric locomotives is less than half that of steam locomotives, but, in addition to this, an electric locomotive can do more work than a steam locomotive, as it requires no time to fill up

with coal and water, or to raise steam, rake fires, or clean firet-ubes. Repairs are also carried out much quicker, so that five electric locomotives will do the work of eight steam locomotives.

Only one man is needed to drive an electric locomotive, whilst two are necessary with steam, and the work is much less hard on the man. Time and space are saved at termini, as turntables become unnecessary, and all electric locomotives standing are available for service, without first having to be filled and fired up. The reduction in the cost of maintenance of stations and bridges will also be important, in consequence of the total absence of steam or smoke.

The whole of the services between London Bridge and Brighton could easily be electrified, all steam, as regards this portion of the line, being entirely done away with. The Eastbourne and Hastings trains would be hauled electrically as far as Lewes, where a steam locomotive would take them to their destination. Many, if not all, the Portsmouth trains would be run electrically as far as Worthing, whence a steam locomotive would haul them to Portsmouth. All towns not on the electrified section would be provided with frequent motor rail cars, steam, electric or petrol, connecting with the nearest station on the electric line, thus providing a much more frequent, as well as quicker, service connecting them with London than it is possible to give now.

Such a transformation would enable a 10 to 15 minute service to be given to Brighton, and a 20 to 30 minute service to all the immediate stations; and the consequent traffic increase should be at least correspondingly large. It is proposed that the non-stop trains should do London to Brighton in about 45 minutes, and the stopping trains in about 60 minutes. The surveys and calculations in connection with this proposal are already far advanced, but the work involved is enormous, and it will be several months yet before any scheme will be ready to present to the Brighton Board for their consideration.

INSTITUTION OF CIVIL ENGINEERS.

EXPERIMENTS ON THE STRENGTH AND FATIGUE PROPERTIES OF WELDED JOINTS IN IRON AND STEEL.*

By T. E. STANTON, D.Sc., M. Inst. C.E., and J. R. Pannell.

THESE experiments were undertaken at the suggestion of Sir John Wolfe Barry in 1908, the object being to obtain a comparison of certain properties of welded joints, made by different processes and by different makers, with the corresponding properties of the unwelded material from which the joints were made. It was hoped that by this means some estimate of the general reliability and efficiency of modern welding processes might be arrived at. In order to obtain material for the work a circular letter was sent from the National Physical Laboratory to various engineers, inviting them to submit specimens of welded joints for testing. Sixteen firms responded to this invitation, and the total number of welded joints received was 167. The method of welding and treatment of the joints was left entirely to the makers, the only condition being that all specimens should be made from bars 1¼in. in diameter. The tests to which the joints were subjected were;—First, a tensile test, and secondly, a fatigue test by the Wöhler method. The former included determinations of the elastic limit, the yield point, the maximum stress, the total elongation, and the general and local elongations.

For the rapid carrying out of the fatigue tests a machine was constructed in which the specimen was rotated at a speed of 2200 revolutions per minute. Owing to the results of a previous investigator with another type of machine having shown a decided reduction of fatigue strength with increased rapidity of stress alternation, preliminary experiments were carried out to determine the amount of this effect for the particular type of machine used. The results showed that for speeds of 200 and 2200 reversals per minute there was practically no difference in the fatigue strength. The assumption was therefore made that the apparent reduction of fatigue strength with rapidity of alternation in the case referred to was a characteristic of the machine used.

The mean results of the tensile tests on the welded joints expressed as a percentage of the strength of the original material from which the joints were made, were:—

	per cent.
Hand-welded iron	89.3
Hand-welded steel	81.6
Electrically welded iron	89.2
Electrically welded steel	93.4

Joints made by the oxy-acetylene process were also submitted by two makers, but the results were not comparable with those obtained by the hand or electric processes.

The various determinations made in the tensile tests showed a distinct want of uniformity in the material in the region of a weld, but the results of the fatigue tests proved that this does not materially affect its resistance to reversals of stress. When failure under alternating stresses of low value takes place, it is invariably due to a defect in the actual weld itself. The number of defective joints which were discovered in the whole investigation, however, leads to the broad conclusion that in important work, where the failure of any particular welded joint may involve serious damage to the structure, the subjection of each joint to a proof-load is still desirable.

FOREIGN patents are being applied for by Herr Ingenior Chr. Oftedahl, of Christiania, for a chemical process whereby he claims that iron and steel plates may become hardened and unpiercable, while at the same time maintaining their normal elasticity, and without being fractured by blows or collision. The inventor, who has devoted several years to the preliminary stages of this discovery, maintains that the chemical substance can be added during the actual process of rolling. Experiments are contemplated at the mills of a large foreign works, and if, as is anticipated, these will be successful, the result will be of immense importance to many branches of the iron and steel industry, and especially in connection with shipbuilding material.

IN describing the new reinforced concrete warehouse of the Mitsu Bishi firm at Kobe, Japan, in the "Proceedings" of the Institute of Civil Engineers, Mr. Naoji Shiraishi gives the following particulars of tests made to determine the strength of the floors in resisting blows:—Upon the supposition that pressed bales of cotton on the top storey might accidentally fall from their piles on to the floor while being handled, it was arranged to use such a bale, weighing 600 lb., as the dropping load, so that the experiments might really represent what would happen. The slabs tested were all six months old, and were supported at two edges only. The bale, suspended from a crane, was dropped through heights of 1ft., 2ft., 3ft., 4½ft., and 6ft. respectively. It was disappointing to find that slight cracks began to appear from the drop of only 3ft., no matter what the specimen of cement used, nor what the type or amount of reinforcement was. With a drop of 6ft. failure was complete in every case. Such resistance to impact was considerably less than expected, and the result of the tests was to give a sharp warning that heavy articles should be handled with great caution on floor slabs.

* Abstract of paper read at the ordinary meeting of the Institution on Tuesday, the 12th December.

FORTHCOMING ENGAGEMENTS.

TO-DAY.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. "Tests on Reinforced Concrete," Mr. E. F. Hunt. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. Ordinary general meeting. Discussion upon "Double-cutting and High-speed Planing Machines," Mr. J. Hartley Wicksteed. Paper to be read and discussed (if time permits), "Oil-burning Locomotives on the Tehuantepec National Railway, Mexico," Mr. R. Godfrey Aston. 8 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne. Author's reply to discussion on paper, "The Relationship between Residuary Resistance Horsepower and Forms of Vessels," Mr. Ernest Saxton White, B.Sc. Paper to be further discussed, "Certain Aspects of Ship Resistance as Disclosed by the Performance of the Corrugated-sided Vessel Monitoria," Mr. Arthur H. Haver, M.I.N.A.

SATURDAY, DECEMBER 16TH.

THE STEPHENSON SOCIETY.—Visit to the Central London Railway's Works and Generating Station at Caxton-road, Shepherd's Bush. Meet at Shepherd's Bush Station, 3 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: GRADUATES' SECTION.—Visit to Messrs. Holzapfels Composition Company, Limited, Works at Heworth. Graduates meet at Aberdeen Wharf, Quayside (opposite Exchange), at 2.15 p.m. Launch will leave at 2.30 p.m. prompt. In the evening the third general meeting of the session will be held in the Institution Rooms, Bolbec Hall, Newcastle-upon-Tyne. A paper will be read by Mr. C. Ian Burrell on "The Design and Construction of Aeroplanes" (Illustrated by Lantern Slides). 7.15 p.m.

MONDAY, DECEMBER 18TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. Cantor Lecture, No. 4, "The Carbonisation of Coal," Professor Vivian B. Lewes. 8 p.m.

AERONAUTICAL SOCIETY OF GREAT BRITAIN.—Royal United Service Institution, Whitehall, S.W. Discussion on "The Military Aeroplane." 8.30 p.m.

TUESDAY, DECEMBER 19TH.

PHYSICAL SOCIETY OF LONDON.—Annual Exhibition at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Afternoon and evening.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—Lecture Theatre, Crystal Palace, S.E. 117th Award of Certificates. Sir Douglas Fox, M. Inst. C.E., will take the chair at 12 noon.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Heriot Watt College, Edinburgh. "The Heriot Watt College Laboratories," Professor Francis G. Baily. 8 p.m.

THE ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. "Some Aspects of Railway Station and Goods Yard Illumination," Mr. Haydn T. Harrison. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. Further discussion on "Experiments on the Strength and Fatigue Properties of Welded Joints in Iron and Steel," Dr. T. E. Stanton and Mr. J. R. Pannell. 8 p.m.

WEDNESDAY, DECEMBER 20TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Testing Works and Museums of Messrs. D. Kirkaldy and Son, Southwark-street, S.E.

ROYAL METEOROLOGICAL SOCIETY.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. Papers to be read: "Solar Halos and Brocken Spectres," Mr. Walter Larden, M.A. "The Statical Changes of Pressure and Temperature in a Column of Air that Accompany Changes of Pressure at the Bottom," Mr. W. H. Dines, F.R.S. 7.30 p.m.

THURSDAY, DECEMBER 21ST.

IPSWICH ENGINEERING SOCIETY.—At the Museum, Ipswich. "The Behaviour of Steam in the Cylinder of a Steam Engine" (Illustrated by Lantern Slides), Mr. W. Longland. 8 p.m.

FRIDAY, DECEMBER 29TH.

JUNIOR INSTITUTION OF ENGINEERS.—Visit the Factory of Messrs. Otto Monsted, Limited, Margarine Manufacturers, at Southall. The party will leave Paddington Station by the 2.23 p.m. train, arriving at Southall at 2.56 p.m.

SATURDAY, DECEMBER 30TH.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. Social Evening for the Junior Section. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Boiler Shop Design," Mr. W. J. Bennett. 6.45 p.m.

FRIDAY, JANUARY 5TH.

JUNIOR INSTITUTION OF ENGINEERS.—The Institution of Electrical Engineers, Victoria Embankment, W.C. Presidential Address on "Engineering Considerations in Wireless Telegraphy," Commendatore G. Marconi. 8 p.m.

FRIDAY, JANUARY 19TH, 1912.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Halls, Glasgow. The "James Watt" Anniversary Dinner.

LAUNCHES AND TRIAL TRIPS.

OTTO TRECHMANN, steel screw steamer; built by Wm. Gray and Co., Limited; to the order of Messrs. Trechmann Brothers, of West Hartlepool; dimensions, 382ft. by 51½ft. by 24ft. 10in.; engines, triple-expansion, 25½in., 40½in., and 67in. by 45in. stroke, pressure 180 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, October 14th.

BOTANIST, steel screw steamer; built by D. and W. Henderson and Co., Limited; to the order of T. and J. Harrison, Liverpool; dimensions, 470ft. by 58ft. by 34ft. 10in.; engines, quadruple-expansion, 25½in., 36½in., 52in., and 74in. by 54in. stroke, pressure 215 lb. per square inch; constructed by builders; launch, December 7th.

NEW ABBOTSHALL, steel screw cargo steamer; built by the Goole Shipbuilding and Repairing Company, Limited; to the order of Messrs. Stocks, Turnbull and Co., Limited, Kirkcaldy; dimensions, 224½ft. by 32ft. by 14½ft.; engines, triple-expansion; constructed by Richardsons, Westgarth and Co, Limited, Middlesbrough; launch, December 7th.

NITROGEN, oil-carrying motor boat; built to the specification of James Pollock, Sons and Co., Limited, 3, Lloyd's-avenue, E.C.; dimensions, 84ft. by 17ft., and draught of 5ft. 8in.; to carry 110 tons of oil; engines, Bolinders direct reversible crude oil marine; launch, recently.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

Manufactured Iron Rising.

THERE has been no abatement of the pressure in the bar industry. Consumers are clamouring for quick deliveries against contracts, and the mills of the district are exceedingly busy. Prices continue to harden. Some makers of merchant qualities now quote £6 15s. at works as a minimum, this being nearly equal to £6 17s. 6d. delivered Birmingham. Staffordshire marked bars continue for the present at £8, with £8 12s. 6d. as the Earl of Dudley's price; but the opinion grows that certainly by the date of the January quarterly meeting, if not earlier, the basis price will be put up to £8 10s. per ton. Merchant hoops are £7 to £7 5s. and nail rods £7 15s. The long expected advance in gas strip has at last been made, the association having now announced an increase of 2s. 6d. per ton. This makes the basis price £6 15s. to £6 17s. 6d., according to quantity. In some quarters an advance of 5s. was expected, and it is pointed out that the revised price is only equal to that for merchant bars. Strip makers have a good amount of work in hand.

Galvanised Iron Exports.

A further slight improvement is reported in the demand for galvanised sheets, and quotations are rather better, at from £11 5s. to £11 10s., f.o.b. Liverpool. Business in black sheets continues good. Producers have no difficulty in obtaining £7 15s. for doubles and £8 5s. to £8 7s. 6d. for trebles, while singles are £7 15s. per ton. Much satisfaction is expressed by galvanisers that the exports last month aggregated nearly 61,000 tons, as against 49,600 for the same period last year, and 54,147 tons in October. The value of the shipments during the month was close on £474,000, compared with £624,700 in November, 1910. For the eleven months of this year the total value was £7,003,823 as against £6,806,828 last year.

Pig Iron Going Up.

The pig iron market is distinctly firmer. Current prices are for immediate delivery, but there is now very little available for prompt sales, consumers having covered near-by requirements. Inquiry for 1912 delivery, however, is active, and on an average an additional 1s. per ton on prompt rates is demanded by smelters for contracts extending to the end of March, 1912. Present quotations are:—Forge pig iron: Staffordshire common, 50s. to 51s. 6d.; part-mine, 52s. to 53s.; best all-mine forge, 80s. to 85s.; for hot-air sorts, foundry, 87s. 6d. to 90s.; and cold blast iron, 105s. to 115s. Northampton forge iron is now a minimum of 51s.; Derbyshire, 52s. to 52s. 6d.; North Staffordshire forge, 51s. to 52s.; and best, 58s. to 59s. An indirect result of the improvement in the iron trade is the large demand for heavy foundry work for mill furniture and heavy machinery. The engineering trades are taking large quantities of forging and similar material.

Flourishing Steel Trade.

There is continuous great activity in all departments of the steel trade, but price movements are discouraged by the attitude of merchants, who are holding off the market as far as they can as a mark of their antagonism to the rebate scheme. Half-product steel producers are firm, sheet bars being quoted at £5 2s. 6d. for Bessemer, and £5 5s. for Siemens qualities. British manufacturers have now practically control of the market, as the Belgian and German syndicates will not undertake deliveries before March, 1912. A curious coincidence is that while Belgian and German half-product steel is advancing there have been successive reductions in America, and prices there are now so low that it is believed some purchases of American billets for delivery here will shortly be found possible. American sellers quote 95s. for bars and billets, April to June delivery of 1912. The advance made last week by the associated steel makers of 5s. per ton upon angles, tees and channels has been followed by an advance by the Staffordshire makers upon similar descriptions of 2s. 6d. per ton. Some uncertainty exists here as to whether the advance by the North-East makers includes plates as well as the descriptions just set out. Staffordshire prices are quoted at £6 17s. 6d. to £7 2s. 6d. for channels, £6 10s. to £6 15s. for girders and joists, £7 to £7 5s. for tees of 5 to 12 united inches, and £6 12s. 6d. to £6 15s. for angles of the same size. In all cases, it should be noted, current selling rates approximate more nearly to the maximum than the minimum of the foregoing quotations.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

A Continued Improvement.

AFTER the dull period prevailing in the early part and, in fact, throughout the year up to the last few weeks, signs are not wanting that an improvement is setting in in this centre. There was a good attendance on the Iron Exchange on Tuesday, and whilst prices showed a much firmer tendency, buyers of pig iron are operating much more freely and exhibit a disposition to cover forward. In English brands Lincolnshire, Derbyshire and hematite were dearer, and for future delivery higher figures were asked all round. Scotch continues very strong. Finished iron and steel steady, and prices to a great extent are in sellers' favour. Copper ruled quiet, but both tough ingot and copper, brass and condenser tubes were dearer. Sheet lead steady, but English tin ingots showed a decline.

Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 54s. 6d. to 55s.; Staffordshire, 55s.; Derbyshire, 55s. 6d. to 56s.; Northamptonshire, 55s. 4d.; Middlesbrough, open brands prompt, 57s. 4d. to 57s. 10d.; January-March, 58s. 4d. Scotch: Gartsherrie, 63s. 6d. to 64s.; Glengarnock, 61s. 6d. (official, 62s.); Eglinton, 61s. 6d., delivered Manchester. West Coast hematite, 66s. 6d. to 67s.; East Coast ditto, 64s. 6d. to 65s., both f.o.t. Delivered Heysham: Gartsherrie, 61s. 6d. to 62s.; Glengarnock, 59s. 6d. (official 60s.); Eglinton, 59s. 6d. Delivered Preston: Gartsherrie, 62s. 6d. to 63s.; Glengarnock, 60s. 6d. (official 61s.); Eglinton, 60s. 6d. Finished iron: Bars, £7 5s.; hoops, £7 7s. 6d.; sheets, £8 to £8 2s. 6d. Steel: Bars, £7 to £7 10s.; Lancashire hoops, £7 7s. 6d.; ditto Staffordshire, £7 7s. 6d.; sheets, £8 5s. to £8 10s.; boiler plates, £7 17s. 6d. to £8; plates for tank, girder, and bridge work, £7 5s. to £7 7s. 6d.; English billets, £5 5s. to £5 10s.; foreign ditto, £4 18s. to £5; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £75; tough ingots, £63 5s. to £64; best selected, £64 5s. to £64 15s. per ton; copper tubes, 9½d.; brass tubes, 7½d.; condenser, 8½d.; brazed brass tubes, 8⅜d.; rolled brass, 7d.; brass wire, 7d.; brass turning rods, 7½d.; yellow metal, 6½d. to 6⅝d. per lb. Sheet lead, £19 10s. to £19 15s. per ton. English tin ingots, £198 10s. per ton.

The Lancashire Coal Trade.

There was a quiet feeling in all departments. House coal was quiet, but slack was steady. There was a fair movement on shipping account.

Trackless Tramway Scheme for Stockport.

At a meeting of the Stockport Town Council, held last week, it was decided to promote a parliamentary Bill empowering the Council to run trackless tramway cars from the Mersey-square,

through St. Petersgate, Market-place, Churchgate, and Offerton, and by way of the Marple-road to Marple. The Marple and the Hazel Grove-cum-Bramhall Councils are supporting the scheme, and the only difficulty to be overcome is the obtaining of power from the Cheshire County Council to run over the Marple and Offerton road.

Rochdale Waterworks.

The contractors for the construction of the reservoir at Buersil have abandoned the work, on the ground that they could not make it water-tight, and the Corporation has now taken the work in hand, and has appointed Mr. Brunt, the waterworks manager, resident engineer to the scheme.

The Textile Boom.

I hear of several new mills being projected in Lancashire. One is a weaving shed at Rishton, to hold 600 looms; another is at Darwen, and will have an equal number of looms; while negotiations are in progress with a view to the erection of a new weaving shed in the Hollins Grove district.

American Cotton Crop.

The census office of the United States Department of Commerce and Labour has issued its sixth report on the amount of cotton of the 1911 crop ginned. This shows that up to the close of November 12,815,000 bales had been ginned, against 10,140,000 on the same date last year, 8,887,000 in 1909, and 11,009,000 in 1908, which year produced the record crop. According to these figures it can be safely estimated that the total crop will be over 15,000,000 bales.

Engineers' Strike.

A strike was declared last Friday of the skilled men at Crossley Brothers' works at Openshaw. The cause of the strike is said to be the action of a speeder-up in the turning department. The men object to the speeding-up process, and claim that the machinery is tested under unfair conditions, not sufficient time being allowed for grinding tools, &c.

A Circular Loom.

The manager of a Clitheroe weaving mill, Mr. Christopher Whalley, has invented a circular loom in which, contrary to the customary practice, the shuttle remains stationary and the loom frame carrying the warp and cloth revolves. The three chief motions of an ordinary loom, shedding, picking, and beating up, are all transformed. The two warp beams of 2544 ends each, the warp threads, the circular reed, the heald frame and healds, the web of cloth, sand roller, and cloth beam all revolve on a central shaft, and as they revolve the weft is drawn into the cloth. As a mechanical contrivance the loom is decidedly ingenious, although some may compare it to a sewing machine in which the needle remains stationary and the machine is caused to reciprocate. Although the central shaft runs on ball bearings, it would appear that the total power expended in driving the machine will scarcely compare favourably with that for the ordinary loom.

Fylde Water Board.

The Fylde Water Board, which controls the water supply of Blackpool, Fleetwood, Lytham, and St. Anne's-on-the-Sea, is about to seek parliamentary powers to construct additional storage and service reservoirs, and to lay additional trunk mains to supplement the supply from the gathering grounds of Bleasdale Falls, near Garstang. It will also be necessary to acquire fresh gathering grounds, and the Board has the river Hodder in view. From this source it is proposed to lay the above new trunk mains to service reservoirs at Westby, near Kirkham, and thence to the coast between Blackpool and St. Anne's-on-the-Sea, a distance of about 34 miles. The Board proposes to construct four storage reservoirs in the neighbourhood of Slaidburn, and the small village of Dalehead will be submerged. Mr. John Cook, A.M. Inst. C.E., the Board's engineer, is responsible for the scheme.

Ashton-under-Lyne, Stalybridge and Dukinfield Waterworks.

The Chew reservoir and works, which include about six miles of pipe lines varying from 24in. to 9in. diameter, 1¼ miles of aqueduct 3ft. 6in. diameter, a tunnel three-eighths of a mile long, five weirs and other subsidiary work, and which were commenced in 1907, are now approaching completion. The reservoir will have a capacity of 200,000,000 gallons, with a top-water area of 50 acres. The top of the embankment, 1605ft. above Ordnance Datum and about 75ft. above the original stream level, will be 12ft. wide, with inner and outer slopes of 2 to 1 and 3 to 1 respectively. The puddle trench is 10ft. wide, and the greatest depth of this trench was at a point 170 yards north of the stream, being about 140ft. below the surface of the ground and 65ft. below the bed of the stream. All the materials have had to be conveyed to the reservoir by a tram-road, nearly 4¾ miles long, connected with the London and North-Western Railway and with the puddle field at Micklehurst. The engineers for the undertaking are Messrs. G. H. Hill and Sons, Manchester. Messrs. Morrison and Mason are carrying out the contract. The Staveley Coal and Iron Company and J. Blakeborough and Sons are supplying the ironwork and valves.

Manchester's New Drainage Scheme.

The new drainage scheme for Manchester, which was evolved by Mr. T. de Courcy Meade, the city surveyor, and approved by Sir A. Binnie, has been sanctioned by Parliament during the past session. The contract drawings have been prepared, and within a week or two contracts will be invited. The city surveyor has already engaged the whole of the staff, both indoor and outdoor, which will be required to supervise the carrying out of the work. The scheme will cost about £1,000,000, and comprises some twenty-nine new intercepting and outfall sewers Immediate works will require over £500,000 of this amount. They include eight intercepting sewers for Moss Side, Rusholme, Fallowfield, and part of Withington.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is a stronger feeling manifested in the hematite pig iron market than has been the case for some time, and prices have very materially hardened during the week. There has been an increased demand for iron, not only on the part of some steel makers, but also from other outside scurces, the local demand keeping steady all the time. Inquiries have also been made for forward deliveries of iron, and business has been done by makers to an increased extent. Mixed numbers of Bessemer iron are quoted at 66s. to 68s. per ton net f.o.b., business having been done at the latter price for delivery ahead. For special sorts of iron there is a shade better demand, and the price runs up to 71s. per ton net. The warrant market is strong and prices there have increased, and now sellers of warrant iron are quoting 64s. per ton, and iron has changed at that figure, and 64s. 4½d. is quoted at a month. The stores of warrant iron now represent 51,746 tons. The prospect of a busier state of affairs in the iron trade is brighter than for some time, but nothing like a "boom" is looked for, and most people will be contented with an increased amount of business.

Iron Ore.

The iron ore trade is fairly well employed. At most of the pits there is a busy state of affairs, but at others again things are quieter. At such mines as Hodbarrow, Park, Roadhead, and in the Cleator Moor district there is marked activity, and good orders are held for local and also outside smelters. From Cumberland ports the shipments are well maintained, but are quiet from Barrow. Prices are firmer with good average sorts at 10s. to 12s. per ton, with the best qualities up to 20s. per ton net at mines. The demand for foreign ores is steady, and last week one cargo of 5600 tons of Spanish ore arrived in Barrow from Benisaf. This was for local use. Into other ports, Workington and Heysham, cargoes are being brought.

Steel.

The steel trade remains much the same as it has been for weeks past. In the rail departments makers are very busy on orders for home and colonial buyers, especially the latter, who are receiving large tonnages, mostly of heavy sections. Good shipments were made recently from Barrow and Cumberland to Queensland and Adelaide. The demand for rails is steady, but there is no expansion of business to note. Heavy sections are at £5 12s. 6d. to £5 15s. per ton; light sections are at £6 5s. per ton; and heavy rails are at £8 10s. per ton. For steel shipbuilding material there is a full demand on local as well as general account, and this is likely to be the case for some time to come, as new orders will shortly be commenced upon. For tin bars, hoops, billets, &c., there is a steady call on home account.

Shipbuilding and Engineering.

In every department of these trades there is a busy state of affairs. The Chinese training cruiser Ying Swei, after her successful trials, is receiving her finishing touches. Her crew arrived some time ago. The first keel-plate has been laid of the Turkish battleship. She has to be delivered in twenty-one months. She will have a speed of 21 knots, and be fitted with 14in. guns.

Shipments.

The shipments last week of pig iron represented 8402 tons and steel 5435 tons, a total of 13,837 tons, and an increase of 678 tons. The shipments this year stand now at 467,154 tons, as compared with 648,502 tons, a decline of 181,348 tons.

Fuel.

The demand for coal is steady, with good Lancashire or Yorkshire steam sorts at 12s. to 16s. per ton. Domestic coal is in better demand at 16s. 1d. to 27s. 6d. per ton delivered. East Coast coke is quoted at 20s. 6d. per ton. At Barrow Welsh coke is being used.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

General Conditions.

THE activity in current business which has been so marked during the present quarter is now not so pronounced, but this is due largely to the approaching holidays and the end of the year. At this period a lull is the invariable rule, and has usually been experienced earlier than has been the case this year. Manufacturers report that they will carry over into the new year a larger volume of work than for some years past. At the same time they are having to pay from 10 to 15 per cent. more for fuel, but purchases of pig iron were fortunately made on a good scale at the recent low level of prices which will cover requirements well into next year. In all branches of the local iron and steel trades the plant is fully occupied, and the holiday stoppages will be made as brief as possible. Production, however, will be affected by stocktaking in many cases, and generally speaking, business is expected to be quiet until after the holidays, with the delivery of pig iron and other raw materials on a reduced scale. But many makers are asking for full deliveries until as late as possible, so as to procure a service of empty wagons in which to load their finished products, for the supply of rolling stock is seriously short of the demand. Prices of pig iron remain very strong, although business is small at the moment for the reasons mentioned. The export trade is well maintained, the Board of Trade returns for November being considered very satisfactory evidence of a sustained demand for Sheffield steel. The items of tools and implements, cutlery and plate also show good increases, and armour plate shipments are being resumed, chiefly for Spain.

The Coal Trade.

The steam coal market remains very steady with an improved tonnage going forward for shipment. Shipping business has been so upset by the dock and railway strikes that there has latterly been considerable pressure for supplies in an attempt to regain some of the lost ground. For the past eleven months exports of coal from Hull show a decline of 421,683 tons. Current market prices are firm at 9s. 9d. to 10s. 3d. per ton at the pits. Numerous inquiries are reported for next year's shipping business, but little actual business has so far been transacted, and buyers are apparently only testing the position. At the time of writing the railway coal contracts have not yet been renewed. The demand for industrial consumption is exceptionally strong, and some contracts have been renewed at advances of as much as 1s. 6d. to 1s. 9d. per ton. The railways are ready buyers of suitable coal on current market terms for stocking purposes. On the whole the output of steam coal is meeting with a prompt demand. Gas coal is also in eager demand, and deliveries against contracts are very full, extra supplies being taken in many cases.

Slacks.

Continued strength may be reported in the market for slacks. Collieries have considerable difficulty in meeting the demand, best sorts being scarce and dearer. Contract renewals are on the basis previously reported, viz., 6d. to 9d. per ton advance. Current market quotations:—Best washed smalls, 6s. 3d. to 6s. 6d.; best hard slacks, 6s. to 6s. 3d.; seconds, 4s. 6d. to 5s. 6d. Up to the time of writing the news of threatened trouble in the Lancashire cotton trade, which is the biggest consumer of slacks, has had little or no effect.

Coke.

Blast furnace coke remains at 12s. 3d. to 12s. 6d. per ton, with a steady business on contract account, the recent advance in the price of pig iron helping the tone.

House Coal.

A quiet trade continues to be done in house coal. Collieries have a fair number of orders on hand, and, with a shortage of empty wagons, the working of the pits has been interrupted. Stocks are small. Prices are maintained at 9d. to 1s. 6d. per ton above contract rates.

Pig Iron.

AT a meeting of the Lincolnshire Iron Association on Friday last week, the basis price of all classes of pig iron was raised 1s. 6d. per ton. This has, of course, been freely discounted by open market values, as previously noted. Derbyshire iron is strongly quoted, some makers asking more than Lincolnshire sellers are. Hematite is equally firm with late rates fully maintained, but business all round is quiet, local users having bought heavily some time ago. Prices are now as follows:—Lincolnshire, No. 3 foundry, 52s.; ditto forge, 51s.; ditto basic, 53s. 6d.; Derbyshire, No. 3, 51s. to 52s.; ditto forge, 49s. 6d. to 50s. 6d., all per ton delivered Sheffield or Rotherham. Hematite is quoted nominally at:—East Coast mixed numbers, 72s. to 73s. net; West Coast, 77s. to 78s., less 2½ per cent. discount; bar iron, £7 5s.; hoops, £7 5s.; billets, Siemens, £7 5s. to £7 10s.; basic, £5 5s. to £5 10s. Ferro-manganese is quoted 10s. higher than a few weeks ago. On the other hand, lower prices are ruling for tungsten and vanadium, the former fetching 2s. 4d. per lb., and the latter a little below 13s. per lb.

The Lighter Trades.

In the cutlery and plate branches makers continue to deal with a record volume of work, and owing to the scarcity of handworkers a larger quantity of table-knife blades are being forged by machinery. The Admiralty requirements for cutlery next year are unusually large, the items for which tenders are asked, including 170,000 ordinary table knives, 9000 ivory-handled table knives, and 9000 electro-plate-handled table knives.

The Doncaster Collieries.

It is reported that sinking operations at Messrs. Pease and Partners' Colliery, Thorne, in the eastern portion of the South Yorkshire coalfield, has been suspended owing to the water trouble. It is now proposed to adopt the freezing process. Coal has been reached at the new Bullcroft Colliery, also in the Doncaster district, where the freezing process had also to be adopted owing to the inrush of water, but the Barnsley seam was reached a week ago at a depth of 662 yards. The bottom part of the seam is 4ft. 5in. in thickness and the top part 3ft. 9in. thick. Sinking operations were begun 3½ years ago, the water trouble delaying operations for nearly two years of that period.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

IT is a long time since the pig iron market in this district has been as lively as it has been this week, and traders, especially those who had anything to sell, have been in particularly good spirits, while prices have risen substantially, so that they are now higher than they have been since last February, and the upward movement is considered likely to be maintained. Speculators are busier, but the chief business is sound and solid, and the iron bought is wanted for consumption. The improvement has all the appearance of a genuine revival, and consumers who have been hitherto very backward about buying, and have let their stocks get very low, are now making haste to replenish them. The demand is therefore somewhat pressing, and consumers are much keener about purchasing than producers and merchants are to sell. As a matter of fact the producers are at present very well situated as regards contracts, and with the tendency of the market so strongly upward they are not prepared to commit themselves much ahead, and are inclined to keep themselves in a position to take the fullest advantage of the "boom" which they believe will be experienced next year. There are, in fact, indications that it has already begun. With labour and political troubles out of the way, the revival which was beginning in August, but was checked by wars and rumours of war, national and industrial, is making itself felt, and the position is made much more favourable in this district by the wonderful shipments of pig iron for the present month, and the rapid decrease in stocks. The exports are indeed unprecedented for the season of the year. The whole market has become very buoyant in tone, and no little excitement has been shown. Cleveland warrants, for which buyers on Thursday last week were offering only 47s. 7½d. cash, were at 48s. 11d. cash on Wednesday last. That is 3s. 2½d. per ton above the recent minimum price. Makers who a month ago were quoting 47s. 3d. per ton for prompt f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron now ask 49s. 3d., and some are so well off for orders that they are out of the market altogether for the present, and refuse to quote even for forward delivery. They, indeed, are more independent than they have been for the last three or four years, and expect to see 50s. reached for No. 3 before the year is out. No. 1 for prompt delivery is up to 53s., No. 4 foundry to 48s. 9d., and No. 4 forge, which promises to be scarce before long, is at 48s. 6d. The supply of No. 1 is also rather short.

Hematite Pig Iron.

Prices of East Coast hematite pig iron have gone up with a run recently, and makers find that their position has improved considerably, as consumers have bought freely, and would have done even more in that line if the producers had been disposed to commit themselves for delivery over fairly long periods. Naturally, in the face of a strongly improving market, the makers are inclined to leave themselves at liberty to take full advantage of the advances of prices which are generally looked for. During the first half of November mixed numbers could readily be bought at 60s. 6d. per ton; this week 64s. per ton for December delivery and 65s. for January have been the quotations, with 66s. for spring delivery. Plenty of consumers are now in the market, and producers have become rather independent, especially since the competition of scrap has largely subsided; their stocks of iron are small, and the condition of business in the steel trade guarantees them a good business over a considerable period. The production of hematite iron is no longer in excess of requirements, and there is no stock of hematite iron in the public stores in this district, that being one reason why there is no speculative business in hematite such as is carried on in connection with Cleveland pig iron. The price of hematite iron in this district is now higher than it has been since the early part of the year.

Iron-making Materials.

The values of these continue to rise, and that substantially, thus partaking of the general upward movement. Rubio ore is quoted for early delivery here at 21s. 6d. per ton, and some merchants quote 22s. for delivery over the first quarter, a figure which is offered by consumers for delivery over the second half of the year. The rate of freight from Bilbao to Middlesbrough has eased from 6s. 6d. to 6s. per ton, and to other ports has fallen in proportion, but that was expected with the termination of the Baltic season. Besides this, less foreign ore is being received in this district, partly on account of its dearness, and Cleveland ironstone is more fully utilised for producing iron for steel-making purposes. Last year the average importation of foreign iron ore into the Tees was 174,000 tons per month, but in October this year the quantity received was only 118,000 tons, and last month under 90,000 tons. That is a rather important point. Ironmasters are finding that they have to pay substantially more for their coke. All the summer and part of the autumn they could easily buy furnace coke of good quality at 14s. 6d. per ton delivered at Middlesbrough, or 12s. 6d. at the collieries, but now they have to pay at least 16s. 6d. for such coke delivered on Teesside, and a considerable number of contracts have been arranged for execution over next half-year at 16s., but that will not be accepted now. It may be said that 16s. 6d. per ton is the best price of the current year. The production of coke is not at present in excess of the requirements, and in many cases on account of the high prices realisable for coal the colliery owners are selling it as coal, for it pays them better to do that than to convert it into coke even at 14s. 6d. per ton at the pit.

Extraordinarily Favourable Statistics.

There is no doubt the "boom" which has appeared in pig iron is being helped forward by the marvellously good returns which are forthcoming with regard to shipments and stocks. December is almost invariably a poor time for exports of pig iron, and no one looks for large deliveries; but this year the shipments are extraordinary, they even exceed those of any other month this year, and that substantially; and, moreover, this is the best December on record in regard to exports. Up to the 13th no less than 62,535 tons of pig iron were shipped from the Cleveland district as compared with 37,585 tons last month; and 31,561 tons in December last year. The best shipment previously this year was in May. The brisk shipments, it is interesting to note, have been brought about by the very dry summer and autumn. Pig

iron, which was bought for delivery over that period, unfortunately could not in many cases be delivered to German and Austrian consumers, because on account of the lowness of the water in the rivers and canals over there navigation had to be suspended or nearly so. A wet November has replenished the rivers, and there is quite a rush to deliver iron which should have gone months ago, but which must go now before the navigation is again closed on account of the frost. Pig iron has been despatched this week which should have reached the consumer in July. Besides this there are uncommonly good shipments to Grangemouth, as merchants are making up for lost time in completing arrears of contracts which were for execution this year. Stocks of Cleveland pig iron in Connal's stores continue to be heavily reduced, and this affords evidence that the production of pig iron in the district is no longer above requirements. The stock has been reduced to 545,814 tons, that being 55,659 tons below the recent maximum quantity.

Manufactured Iron and Steel.

Trade continues to improve very satisfactorily in the finished iron and steel industries, and seems to justify advances in prices. The associated firms in this district have put up their quotations for plates and angles 5s. per ton, the first change that has been made in their prices since October, 1910, and now steel ship plates are at £7, and steel ship angles at £6 12s. 6d., both less 2½ per cent., and also less 5s. per ton rebate where the consumer gets his supplies exclusively from the associated firms. The advance was not unexpected after the arrangement had been come to a short time ago about the giving of the rebate. It is estimated that shipbuilders have ordered during the last three weeks fully a quarter of a million tons of material for delivery over next year. It is believed that producers of other descriptions of finished iron and steel will shortly follow the example of the plate and angle makers, more especially the bar manufacturers, who have maintained the present quotations for quite two and a-quarter years—£7, less 2½ per cent. for common iron bars, £7 7s. 6d. for best bars, and £7 15s. for best best bars, less the usual discount. Steel bars are much lower than this, £6 5s., less 2½ per cent. f.o.t., being taken for ordinary quality. Steel joists are at £6 10s., steel sheets at £7 7s. 6d., steel hoops at £6 12s. 6d., and steel strip at £6 10s., all less 2½ per cent. f.o.t. Good orders for galvanised and corrugated steel sheets have been secured during the last fortnight, and the price varies between £11 and £11 5s., less 4 per cent. f.o.b., for 24 gauge. Heavy steel rails are at £5 12s. 6d. to £5 17s. 6d. net f.o.b.

Shipbuilding.

The shipbuilding industry must be accounted wholly satisfactory. Never was the production greater, and there is still a good inquiry for new tonnage, notwithstanding the rise in prices. But the high rates of freight are very tempting, and some owners are giving extraordinary prices for second-hand steamers in order to participate more fully in the revival that is in progress. Further advances in freights are predicted for January, and already they are very high and remunerative. Swan, Hunter and Wigham Richardson have secured a second order for an oil tanker of 9000 tons for C. T. Bowring and Co., of Liverpool, and another patented ore carrier of about 10,000 tons dead weight is to be built on the Tyne for Mr. P. A. Grön, Norway, as well as an oil tank steamer for the Anglo-Mexican Oil Company. Mr. M. S. Pederson, of Tonsberg, has ordered two steamers of 3600 tons each from Wear yards. A very large tonnage of steamers is now in course of construction at the yards on the North-East Coast for Norwegian owners—over 100,000 tons it is calculated. Ship repairing is somewhat quiet; freights are so good that owners put off having their steamers sent into dry dock as long as possible, and only repairs that are absolutely necessary are attended to. One of the seven torpedo-boat destroyers for the British Admiralty will be constructed by Parsons' Marine Steam Turbine Company at Wallsend-on-Tyne.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

Further Advance in Prices of Warrants.

THE Glasgow pig iron warrant market has been strong this week, with an active business in Cleveland iron. The favourable Board of Trade returns, and the more peaceful outlook in labour negotiations, exerted a strengthening influence on the market. Advices from America in the last few days were also more satisfactory, and this, added to the increasing activity in the manufacturing branches of the iron and steel trades, had a further good effect, and prices of warrants had a further substantial advance. Business has been done in Cleveland warrants since last report from 47s. 8d. to 49s. cash, 48s. 3½d. to 48s. 11½d. one month, and 48s. 9½d. to 49s. 3½d. three months. Transactions in Cleveland iron also took place early in the week at 48s. 5½d. for delivery in eleven days, and 48s. 7½d. twenty-eight days. The consumption of Cleveland pig iron in Scotland is on an extensive scale, but the imports are not up to what they were a year ago. In the past week the arrivals at Grangemouth of pig iron from Middlesbrough and district amounted to 12,631 tons, showing a decrease of 2870 tons compared with the imports in the corresponding week of 1910.

Scotch Pig Iron Market.

The demand for Scotch pig iron, ordinary and special brands, has been on a comparatively moderate scale. Current shipment requirements are easily met, and home consumers are not purchasing very much iron in view of the near approach of the holidays. But the tendency of the market has been firmer in sympathy with warrants. Free at ship at Glasgow, Govan and Monkland, Nos. 1, are quoted 57s. 6d.; Nos. 3, 56s.; Carnbroe, No. 1, 61s. 6d.; No. 3, 57s. 6d.; Clyde and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s.; Gartsherrie, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Summerlee and Langloan, Nos. 1, 64s.; Nos. 3, 60s.; Coltness, No. 1, 82s. 6d.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s.; No. 3, 56s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 58s. 6d.; No. 3, 56s. 6d.; Shotts, at Leith, No. 1, 63s. 6d.; No. 3, 58s. 6d.; Carron, at Grangemouth, No. 1, 64s.; No. 3, 59s. per ton. There are 84 furnaces in blast in Scotland, compared with 86 at this time last year. The shipments of pig iron from Scotch ports in the past week were 1823 tons foreign and 2341 coastwise, the total of 4164 tons being 1642 tons below the quantity despatched in the corresponding week of last year.

Upward Tendency in Hematite.

The business in hematite pig iron in the last few days has been so considerable that makers, who are under obligation to supply large quantities of iron under contract, intimated a substantial increase in prices. Within the last few weeks business had been done from 64s. to 65s. 6d., and the price was at 66s. last week. But merchants are now quoting for fresh orders 68s. per ton for delivery at West of Scotland steel works. Hematite statistics are becoming rather more favourable, and on this account, and also because of the general upward tendency of iron prices, Cumberland hematite warrants are higher, business having been done this week in our market at 64s. 7½d. for delivery f.o.b. Cumberland ports.

Rise in Prices of Steel.

Following the advance made a few days previously in the North of England, the Scotch steelmakers have raised their prices 5s. per ton. They now quote steel angles £6 15s., ship plates £7 2s. 6d., bars £7 15s., and boiler plates £7 17s. 6d., all subject to the usual 5 per cent. discount for delivery in the Clyde district. At the same time, ship plates have been raised 5s. for export to £6 15s. Bars are quoted for export £6 2s. 6d., angles £5 15s., and boiler plates £7 per ton. For several days before the prices were raised purchasers had an opportunity of buying at former rates, and this they appear to have freely done, merchants, shippers and home consumers having all purchased for near delivery. It is understood that some of the contracts placed with the steel makers will involve delivery over a considerable part of the coming year. A large proportion of the material ordered is for shipbuilding purposes. There has been an active inquiry for steel goods for Australia, India and Japan. Welsh firms are reported to have sold a considerable amount of steel to Scotch users at and somewhat under the prices charged by Scotch producers. There is now, however, very little competition in steel on the part of the Continent, the large demand there absorbing the native output. An active business continues to be done in sheets for export.

The Malleable Iron Trade.

Although malleable iron has not kept pace with the warrant and steel markets, the tone appears to be decidedly firmer, and quotations are generally given at about 2s. 6d. better than recent figures. The works being as a rule well employed, the expectation is that merchants and consumers may likely have to give a little more money for prompt supplies. Quotations are now on the basis of £6 2s. 6d. to £6 5s. for crown bars, and the latter figure is regarded as all the more likely seeing that £6 7s. 6d. has even been named in the last day or two as possibly attainable in certain circumstances. For export, common (unmarked) bars are at £5 16s. 3d., and crown bars £5 18s. 9d. net.

The Coal Trade.

There is no abatement of activity in the coal trade. At the ports the pressure for shipment has become severe as the holidays approach, and complaints are heard that transit facilities are on some lines quite inadequate to the present requirements of the trade. Consumers are now endeavouring to fix supplies for delivery over the early months of the coming year. Merchants and coalmasters do not seem anxious to close with such business unless there should be a special inducement in prices offered, but it is reported that on such terms a fair business of this description has been done. F.o.b. at Glasgow, steam coal is quoted 10s. 6d. to 11s.; ell, 11s. 6d. to 12s.; splint, 11s. 6d. to 12s. 6d.; washed treble nuts, 11s. 3d. to 11s. 6d.; doubles, 10s. 3d. to 10s. 6d.; and singles, 9s. to 9s. 6d. per ton. Manufacturing supplies are met about former terms, small hard coal being a little more plentiful. House coal for home use is a shade firmer, owing to increasing demand.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade.

THE return of storms again affected operations on 'Change, and led buyers to adopt a halting policy in the belief that prices which were becoming firm, and upwards, might weaken. This did not apply to the majority, for it was authoritatively said that the chartering of steamers had been so heavy of late that sellers were, in most cases, well booked for the whole output of pits for the remainder of December, and also for a good part of January. Cardiff and Monmouthshire steam coals were reported to have been very heavily sold.

Present State of Trade.

Mid-week it was reported on 'Change that tonnage was still insufficient to meet the requirements of shippers, steamers having been much delayed by the stormy weather; but the firmness of the market was shown by the difficulty that buyers had in getting even slight concessions. It is thought that with such enormous quantities of coal booked a period of pressure was inevitable. Very heavy loading pressure is expected even over the greater part of January. The coal requirements of the Italian navy and State Railway are as pressing as ever. Evidently the merchants of that country are still very short in stocks. Prospect upwards.

Latest.

French Western State Railways contracts, officially placed on Monday, give an indication of the result of the unrest in Wales and the fear about getting regular consignments. It is understood that the orders for 21,000 tons of large steams were placed with French and German firms. The orders for 150,000 tons small were reported to have been divided among various firms, contract subject to conditions which include fines for an excess of ash over 13 per cent. Prices reported: 16f. and 17f., Dieppe or Havre, into truck, inclusive of import duty. Latest prices:—Best Admiralty, 17s. 3d. to 17s. 6d.; best seconds, 16s. 6d. to 17s.; ordinaries, 15s. 6d. to 16s. 3d.; best drys, 16s. 3d. to 17s.; ordinary drys, 15s. 3d. to 15s. 9d.; best washed nuts, 14s. to 15s.; seconds, 13s. 6d. to 14s. 6d.; best washed peas, 12s. 6d. to 13s. 6d.; seconds, 11s. to 12s.; best bunker smalls, 9s. to 9s. 3d.; best ordinaries, 8s. 3d. to 8s. 9d.; cargo smalls, 7s. to 7s. 6d.; inferior smalls, 6s. to 6s. 9d.; washed smalls, 8s. 6d. to 9s.; best Monmouthshire black vein, 16s. to 16s. 3d.; ordinary Western, 15s. 3d. to 15s. 9d.; best Eastern Valleys, 14s. 6d. to 15s.; seconds, 13s. 6d. to 14s. Bituminous: Best households, 17s. to 18s.; best ordinaries, 15s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. to 17s. 6d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 9d. to 10s.; No. 2 Rhondda, 13s. 3d. to 13s. 6d.; through, 9s. 9d. to 10s. 3d.; smalls, 6s. 3d. to 6s. 9d. Patent fuel, 16s. to 17s. Coke: Special foundry, 24s. to 25s.; foundry, 17s. 6d. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, ex ship, 29s. 6d. to 30s. 6d.

Newport (Mon.) Coal.

The shipments of coal were heavier than they have been for a long time, totalling 120,065 tons to foreign, and 14,199 tons to coast destination. Midweek: Notwithstanding storms there were sufficient ready steamers to keep the loading berths well occupied. Shipments were heavy, and most shippers were able to keep the pits supplied with empty wagons, and thus ensured regular operation. Sellers held exceptional order books, and were not inclined to relax values either for spot or forward. Some sellers were declining to accept further business for the present. Smalls firm. Latest quotations:—Best black vein, 15s. 9d. to 16s.; Western Valleys, 15s. to 15s. 6d.; Eastern Valleys, 14s. 3d. to 14s. 9d.; other kinds, 13s. 3d. to 13s. 9d.; best smalls, 7s. 6d. to 8s.; seconds, 7s. to 7s. 6d.; inferiors, 6s. tc 6s. 9d. Bituminous: Best house, 16s. to 17s.; seconds, 15s. to 15s. 6d. Patent fuel, 16s. to 16s. 6d. Coke: Foundry, 17s. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 28s. to 30s.

Swansea Coal Trade.

The shipments of coal and patent fuel amounted to 79,872 tons, coal being 66,962 tons. Midweek: No material alteration in anthracite; undertone steady to firm; Swansea large in request; sellers fully stemmed; red vein firmly maintained, but machine coals, second qualities, weaker. Beans and peas firmer; rubbly culm rather slow; duff steady; no change in steam. Best anthracite, 21s. to 23s. net; seconds, 19s. 6d. to 20s. 6d. net; red vein, 13s. 6d. to 14s. 6d., less 2½: machine-made cobbles, 19s. 6d. to 22s. 6d. net; Paris nuts, 22s. 6d. to 25s. net; French nuts, 22s. 6d. to 25s. net; German nuts, 23s. 6d. to 25s. net; beans, 19s. 6d. to 22s. 6d. net; machine-made large peas, 11s. 9d. to 23s. 3d. net; rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d. net. Steam coal: Best, 17s. to 18s. 3d.; seconds, 13s. 9d. to 14s. 3d.; bunkers, 10s. 3d. to 11s.; small, 5s. to 7s., all less 2½. Bituminous: No. 3 Rhondda, 17s. to 18s.; through, 13s. 9d. to 14s. 3d.; small, 10s. 3d. to 11s., patent fuel, 14s. 6d. to 15s. 3d., all less 2½.

Iron and Steel.

Last week was a busy one at Dowlais, the men working energetically after the satisfactory ending of late contention. As already noticed, the arrangement between the management and the men gives the 2000 employés much better encouragement, and the men are further gratified by knowing that their trade union is to be recognised. The Saturday back money amounted to a good round total. The annual wage increase will be £12,000. There was a little disagreement at the beginning of the week, but it was soon arranged. There is more vitality in the iron and steel trades. Rail shipments less this week on account of storms. Port Talbot steel works have had a further extension by the erection of a new section rail mill and will require fifty additional men. Standard rails which had to be re-melted will soon be reheated into lengths of a smaller section rail, thus saving much expense. Latest quotations:—Pig iron: Hematite mixed numbers, 63s. 10½d. cash, 64s. 1½d. month; Middlesbrough, 46s. 9d. cash, 49s. month. Scotch, 54s. 7½d. cash, 54s. 10½d. month; Welsh hematite, 70s. dd.; East Coast, 69s. c.i.f.; West Coast, 69s. c.i.f.; steel bars, £5 to £5 2s. 0½d. Siemens: Bessemer, £5. Iron ore: Rubio, 20s. to 20s. 6d.

Tin-plate.

Shipments of tin-plate last week totalled 105,005 boxes, receipts from works 102,643 boxes, present stocks in warehouses and vans 85,761 boxes. The importation of foreign steel bars was large, but the demand for tin-plate manufacture of home bars equalled supplies. This is expected to lessen for a short time, as many of the furnaces will be let out for repairs at holiday time. Briskness continues in the trade in all its branches, and as the rival unions have settled their differences, temporarily at all events, industrial peace, as an authority remarks, is assured over Christmas time. Latest:—A steady business is taking place in tin-plates, but prices are not regarded as satisfactory to manufacturers. The steel market is strong, and likely to continue so, and costs of manufacture all round show a tendency to advance. Latest quotations are:—Ordinary Bessemer and Siemens processes, 13s. 9d. to 13s. 10½d.; ternes, 24s. 6d.; C.A. roofing sheets, £9 to £9 5s.; big sheets for galvanising, £9 to £9 5s.; finished black plates, £11 to £11 5s.; galvanised sheets, 24 G, £11 10s. per ton; block tin, £196 cash, £186 three months. Other quotations:—Copper, £60 5s. cash, and £61 1s. 3d. three months; lead, English, £16; Spanish, £15 13s. 9d.; spelter, £26 17s. 6d. per ton; silver, 25⅞d. per ounce.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 6th.

SINCE the revival of car building orders a few weeks ago, the total number of cars ordered amounts to 46,850, including 2000 just ordered by the Missouri-Pacific. The latest orders for rails are from the Delaware and Hudson and the Lehigh Valley, and call for 10,000 tons for each railway. The order for material for the Brooklyn bridge approach amounts to 12,000 tons. The requirements in structural steel of the Western Union building in this city will call for a very large quantity; but the figures are not yet known. The improvements involve an expenditure of 2,500,000 dols. The New York Central will also be in the market very soon for large tonnages for terminal work, including two viaducts. Other inquiries are in sight, and the structural and plate mills will be well supplied with business for the winter and spring. The shipyard demand is assuming more significant proportions. Much interest is growing in the opportunities which will be afforded by the opening of the Panama Canal. Crude iron has been more active than it has been for about a year, and basic and Bessemer are now engaging the attention of most of the larger consumers and very many of the smaller. Crude steel is also more active than for many months. The sheet mills are now operating to about 80 per cent. of their capacity, and other branches are correspondingly active. The National Tube Company has withdrawn its assurances of the continuance of low prices mentioned some weeks ago. The steel makers look for a continuous and heavy demand. The copper market is strong and stocks are decreasing. It is expected that next Friday's statement will show a decrease of 10,000,000 lb. Exports for the past month, 65,000,000 lb.; production, about 115,000,000 lb. per month.

CONTRACTS.—Amongst other orders during the last month the Yorkshire Boiler Company, Limited, Leeds, received instructions from the India-office to supply one of its 24ft. by 8ft. 6in. Yorkshire boilers for the Aden Waterworks. This boiler, when working under normal conditions, is designed to give an evaporation of 12,000 lb. of water per hour.—Ed. Bennis and Co., Limited, have within the last few weeks received numerous orders for smokeless chain-grate and other stokers, the orders coming from Japan, India, Canada, and the Continent, as well as from this country.—An electro-galvanizing plant for coating boiler tubes and special fittings is being erected in accordance with Mr. Sherard Cowper-Coles' designs and specifications for the Las Sociedad Espanola de Construccion Naval, Ferrol, Spain, which company is entrusted with the building of the new Spanish navy.

CHEAP CABLE MESSAGES AND SECRET WIRELESS TELEGRAMS.—At the invitation of the United Cheap Cables Company, Limited, of 37A, Finsbury-square, E.C., we were recently invited to inspect the experimental apparatus used in connection with the Johnson-Varley systems of type cablegraphy and secret wireless telegraphy. At present the real apparatus which will be employed has not been constructed, but that brought to our notice demonstrated the general principle. In the cablegraphy system induction coils are used which send intermittent currents through the cables which act on receiving instruments at the other end in which tuned reeds are employed representing letters and numerals. In all there are 49 different tuned signals to each machine, the whole of these ranging within one semitone. Each reed at the receiving end will only respond to a certain number of current impulses sent by the induction coils, the breakers of which are adjusted to work at different rates. This enables each letter or numeral to be sent by one quick depression of the key, and, as the Morse system requires an average of four impulses per letter, the speed of sending is quadrupled. At the sending end a keyboard will be used similar to that of a type-writing machine, and the letters are printed at the receiving end. Several transmitters can work at the same time over one cable. In the new system of wireless telegraphy the spark is continuously passing between the gap, but at each signal its intensity is varied. It is claimed that it is absolutely impossible for anyone to pick up messages which are not intended for them. This is brought about by the system of tuning adopted, which is based on the reed principle. A receiver tuned with a particular transmitter will only respond with that transmitter. A triple transmitter can be used having three differently tuned reeds, one for secret messages, another common to a given number of stations, and a third which could be used for messages of general interest. The system necessitates the use of a special coherer, which is constantly being de-cohered by a spindle running at high speed in the centre of a small glass tube partially filled with iron filings.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(From our own Correspondent.)

Rheinland-Westphalia.

BOTH inland and foreign demand being active, employment at the various establishments has increased, and the tone of the market is decidedly firm. Many shops are engaged to their utmost capacity, and very long terms of delivery are being stipulated for. Prospects generally are considered favourable. In raw material a steady business is transacted, but the blast furnaces show some reserve as regards the placing of large contracts. In sectional iron a good business is being done ; bars are firm and well inquired for, both on foreign account and for home consumption. Heavy railway material continues in very good demand. Hoops show some improvement; export prices are stiffening. The Hoop Convention contemplates an advance in quotations, which at present are M. 127.50 to M. 130 p.t. A very good demand for plates comes in from the shipbuilding industry. Prices for boiler plates and for sheets have advanced M. 5 p.t., and an upward tendency is perceptible in wire and wire articles. On the 24th inst. a meeting of the Wire Rod Convention is to take place, when the prices for 1912 will be fixed.

Steel Convention.

Sales of the Steel Convention in October of this year have been 598,212 t., as compared with 553,643 t. in September of this year, and 487,490 t. in October, 1910. Of the above-named quantity 352,545 t. were bars, as compared with 324,166 t. in September of this year and 289,849 t. in October, 1910 ; drawn wire, 72,992 t., as compared with 68,924 t. and 60,900 t. ; plates, 101,828 t., as compared with 93,060 t. and 78,984 t. ; pipes, 20,182 t. ; as compared with 17,708 t. and 13,371 t. ; castings, 50,665 t., as compared with 49,785 t. in September of this year and 44,386 t. in October, 1910.

Production of Pig Iron.

Statistics given by the Union of German Iron and Steel Masters show the output of pig iron in Germany, including Luxemburg, for November of this year, to have been 1,313,896 t., as compared with 1,334,941 t. in October, 1911, and 1,272,333 t. in November, 1910. Production in the different sorts of pig iron was as follows :—Foundry pig, 259,292 t., as compared with 262,961 t. for the same month in 1910 ; Bessemer, 41,687 t., as compared with 35,365 t. in November last year ; basic, 831,662 t., as compared with 790,701 t. ; steel and spiegeleisen, 142,862 t., as compared with 125,844 t. ; forge pig, 38,393 t., as compared with 57,462 t. in November last year. Output during the period from January to November of this year was 14,156,586 t., as compared with 13,486,241 t. in the corresponding period the year before.

Coal in Germany.

In the Rhenish-Westphalian coal trade an upward tendency is reported, in spite of the want of wagons. From Silesia also good accounts are coming in as regards the business in engine and house coal.

Austria-Hungary.

Iron and steel have continued firm during the week. Owing to the exceptionally mild weather, activity in the building trade has continued brisk until now, and the demand for all descriptions of structural iron has consequently been extensive. Both wagon and locomotive builders complain of insufficient employment, but prospects have slightly improved quite recently, and the State Railways have resolved to place large contracts for wagons next year. There is some talk of the wagon builders having promised to deliver 12,000 wagons within three years ; 176 locomotives are reported to be required for 1912. Nothing of interest can be reported concerning the coal trade in Austria-Hungary, demand and inquiry being regular as before.

The Belgian Iron Market.

Prices have further advanced during the past week. Steel plates for export from the Charleroi district are quoted £6 to £6 2s. f.o.b. Antwerp, as compared with £5 19s. to £6 1s. p.t. last month. Not only on foreign but also on home account purchases have increased, and producers have therefore advanced the inland rates, especially those for iron bars, which are 137.50f. to 140f. p.t., as compared with 132.50f. to 137f. p.t. previously, and they may be regarded as in proportion to the export rates. A more favourable condition of wire and wire articles has been perceptible since last week, and this has favourably influenced prices ; exports in wire and wire articles for the first nine months of this year were 47,320 t., as compared with 42,390 t. in the same period last year. The semi-finished steel trade is in a most favourable condition, and inland consumption has been steadily increasing. Inland prices are very firmly maintained. During the first nine months of this year import in raw and rolled bars was 48,670 t., as compared with 41,680 t. in the same period last year. Germany is the principal consumer, 19,000 t., and Luxemburg, 18,100 t. ; also France, 13,870 t. Export in the above-mentioned articles was 28,660 t., as compared with 24,330 t. in 1910 and 25,730 t. in 1909. In steel billets and plates this year's strongly rising export is remarkable, being 66,400 t., as compared with 43,100 t. in 1910 and 43,600 t. in 1909. Germany is the chief consumer. Scrap iron has not improved ; on the contrary, 60f. p.t. is the present average quotation, as compared with 61f. in September and 64f. p.t. in July of this year. The dulness in scrap iron is partly due to heavy and increasing supplies, and also to the hand-to-mouth buying that is going on. Owing to the increasing number of blast furnaces in Belgium, consumption in iron ore has strongly increased, supplies coming chiefly from France, but Germany has gained ground this year. Total import in iron ore till the end of September this year was 4,160,000 t., or nearly 300,000 t. more than last year. Compared with 1909 the increase is 965,000 t. Export in iron ore was naturally low in consequence of the strong inland consumption, and was 375,670 t. only, as compared with 445,300 t. in the previous year.

Iron and Steel in France.

For some weeks past a marked upward movement has been noticed in the French iron industry. In the Loire district merchant iron stands at 182.50f. p.t. at works, for orders of at least 10 tons, while the usual advances come into force for smaller orders. The works of the Nord are likewise quoting higher prices, but 155f. p.t. is generally quoted and very firmly maintained. The Union of Paris retail merchants has raised merchant bars and girders 5f. p.t., plates 10f. p.t. ; plates and sheets are especially well inquired for. A rise in prices for castings is expected for next year. Sectional iron and rails are readily disposed of, and rolling material continues in very good demand. The State railways have given out orders for 17,500 t. rails recently. A favourable condition continues to prevail on the French coal market. Extensive forward sales have been effected during the past few weeks and stiffness in prices has increased.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that Mr. Francis W. Frost, formerly secretary and treasurer of the "Engineering News" Publishing Company, has been elected to the office of vice-president and treasurer of Suffern and Co., 96, Wall-street, New York City.

THE address of Mr. T. Murphy, hon. secretary of the British Foundrymen's Association (London and District Branch), will in future be 54, Rosebery-avenue, London, E.C.

CATALOGUES.

LACY, HULBERT AND CO., Limited, 91, Victoria-street, Westminster, S.W.—This is a leaflet dealing with rotary pumps for all kinds of liquids.

J. COWENS AND CO., Consett Chambers, 116, Pilgrim-street, Newcastle-on-Tyne.—An interesting little book on practical case hardening by E. J. Phillips has reached us.

THE WESTINGHOUSE COOPER-HEWITT COMPANY, Limited, 151-2, Saffron-hill, Holborn-circus, London, E.C.—Lists Nos. 17, 21, 25, and 30 have reached us. These deal with the Westinghouse silica lamp, light transforming reflectors for mercury lamps, and mercury vapour lamps for alternating current.

SCHAFFER AND BUDENBERG, Limited, Manchester.—This firm has sent new descriptive price lists dealing with relief and safety valves, section 6 ; indicating gears, section 19 ; and the Concentra oil pump, section 22. The lists are intended to be incorporated with the existing catalogues already issued by the above firm.

THE INDIA-RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS COMPANY, Limited, Silvertown, London.—This is a catalogue having reference to twin cables, concentric and high-tension cables, flexible conductors, and cords. All the cables dealt with in this list are manufactured in conformity with the rules of the Engineering Standards Committee.

THE BRITISH ALUMINIUM COMPANY, 109, Queen Victoria-street, E.C.—"Aluminium in the Service of Electric Traction" is the title of a pamphlet sent to us by this firm. It summarises some of the applications of the metal to railway service, and deals with the use of aluminium in car construction. From the same firm we have also received a leaflet dealing with torsion sleeve joints for overhead aluminium transmission lines.

J. SAGER AND CO., Limited, Canal Works, Halifax.—This is a little catalogue dealing with a hand and power-feed planing machine for wood workers. In nearly every class of wood-working the most common operation called for after sawing is planing in some form or another, and it is claimed that there is very little straight work planing which cannot be done with this machine in a very economical way. The machine is said to be simple to operate, and will perform a greater variety of operations with fewer changes than any other machine yet introduced.

W. J. TRANTER'S BOILER APPLIANCE COMPANY, Tibbington Works, Prince's-end, Tipton, Staffs.—This firm has sent us a coloured illustrated sheet showing the brickwork setting of a Lancashire boiler, together with Hurd's patented inspection covers and seating blocks. The covers form a key or starting point for the boiler covering composition, and they can be swung round for inspection and cleaning purposes. On the side of the cover which comes nearest to the boiler a strip of sheet steel is inserted, which forms the floor of a trough, the upper part of the cover forming one side and the boiler shell the other side. The space thus formed is filled in with cement, sand, &c., and the joint is made gas-tight.

SIEMENS BROTHERS, Caxton House, Westminster, S.W.—Pamphlet No. R.S. 7 has reached us. It supersedes the pamphlet issued in August, 1909, and deals with the Siemens battery signal machine which has recently been improved. Whilst the general features of the machine are retained, modifications have been made by substituting spur gearing for worm-driven machines. This has had the effect of greatly increasing the efficiency, for whereas with the old pattern machine the time taken was 8 to 9 seconds to lower a standard signal arm, with the new form of machine only 4 seconds are taken with the same expenditure of current for the time being, and therefore the life of the battery is proportionately longer. We have also received catalogue No. 535, which deals with telephone apparatus. This is an extensive publication containing over 600 pages, in which a great many things used in connection with telephone systems are described.

THE BRITISH INSULATED AND HELSBY CABLES, Limited, Prescott, Lancashire.—This is a pamphlet dealing with the B.I. fast-speed polechanger and a new method of closed-circuit working. The B.I. polechanger is capable of transmitting perfect Wheatstone signals at a speed of over 400 words per minute, the conditions of test being exactly the same as those prescribed for the standard relay of the British Post-office. This instrument, therefore, marks a great advance in current-reversing apparatus, and will simplify the construction and working of fast repeaters. It is obvious also that an instrument capable of working at such a high speed will transmit signals at key speed much more perfectly than a polechanger working somewhere near its limit of speed, and consequently the B.I. polechanger should prove of great value on long and difficult lines, more particularly when used in local circuit on difficult quadruplex sets where it is important to reduce dash clipping and dot dropping to a minimum. The B.I. polechanger is made in five different patterns. Those instruments actuated by line currents are polarised according to Vyle's patents, and in consequence possess advantages now well known to telegraph engineers.

FRANK WIGGLESWORTH AND CO., Limited, Clutch Works, Bradford.—An extensive publication entitled "Mechanical Transmission of Power" has reached us. Among other things it deals with shafting collars and couplings, plummer blocks, adjustable hangers, wall brackets, sole plates, wall boxes, stools, column fixings, swivelling bearings, roller bearings, ball bearings, heavy plummer blocks and sole plates, anti-friction metal, belt and rope pulleys, interchangeable cast iron split bushings, cast iron sleeves for loose pulleys, cast iron plate pulleys, fast and loose pulleys, special arrangements of dead and fixed pulleys, belt shifting gears, guide pulleys, step cone pulleys, expanding belt pulleys, rope guide pulleys, helical gearing, friction clutches, friction clutches and loose pulleys, band friction clutches, shell friction clutches, shell friction clutch couplings, high-speed disc friction clutches and pulleys, disc friction clutch couplings, multiple disc friction clutches, plummer blocks for hollow sleeves, cone clutches, operating gear for friction clutches, haulage gears, &c. Besides giving prices and other particulars relating to the firm's manufactures the catalogue also contains some useful information which should prove of value to engineers who have to deal with mechanical transmission problems.

THE HYDRAULIC ENGINEERING COMPANY, Limited, Palace Chambers, Bridge-street, Westminster, S.W.—An extensive and well-bound catalogue has been forwarded to us by this company. The Hydraulic Engineering Company, having been continuously engaged in the manufacture of hydraulic machinery of all kinds worked from the public hydraulic supply system since the first of these systems was put into operation in Hull, now thirty-four years ago, is able to offer advantages to consumers of the public power in the supply of hydraulic machinery, and fulfilling the requirements of the supply companies and corporations. Moreover, for a small annual sum the company undertakes the periodical inspection of hydraulic machinery upon the consumer's premises. No adequate idea of the very wide field which this catalogue covers can be given here, but some conception of its contents may be gathered from the following list of headings of the sections into which the publication is divided. These are as follows :—Hydraulic coal hoists and wagon lifts, hydraulic cranes, bridge and lock machinery, hydraulic and electric capstans, hydraulic jiggers, lifts, and cranes for general use in buildings, pumping engines for hydraulic power, belt and electrically driven pumps, hydraulic accumulators, hydraulic intensifiers, stop and other valves, Pelton high-pressure motors, hydraulic engines, hydraulic presses and machine tools, pumps worked by hydraulic power, injector fire hydrants and hydraulic ejectors. The catalogue is admirably illustrated, printed on excellent paper, and altogether it is a very creditable production.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

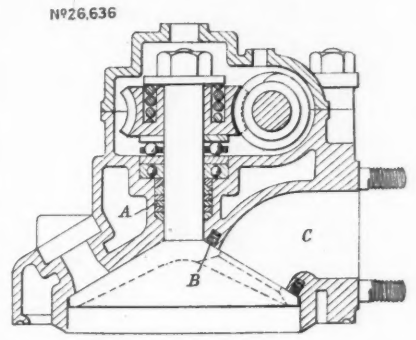
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of the Patent.

INTERNAL COMBUSTION ENGINES.

26,636. November 16th, 1910.—IMPROVEMENTS IN THE VALVES OF INTERNAL COMBUSTION ENGINES, Professor A. K. Huntington, King's College, Strand, London, and J. H. Maltby, of Sandgate, Kent.

The engraving is largely self-explanatory. A conical valve pierced by a port is rotated from the engine shaft by skew gear-

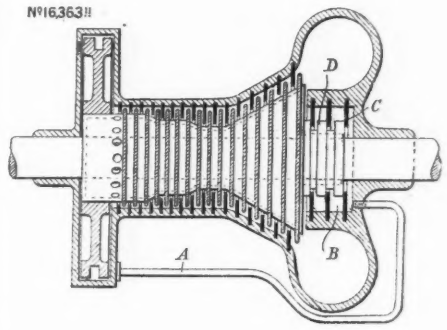


ing. The spindle of this valve is packed with asbestos at A to prevent oil from the gearing reaching the interior of the cylinder. A packing-ring B pressed from behind by springs fits into a recess surrounding the mouth of the exhaust port C. This ring prevents leakage, which would otherwise occur if the valve lifted slightly from its seat.—*November 22nd*, 1911.

TURBINE MACHINERY.

16,363 of 1911. Date of application December 9th, 1910.—IMPROVEMENTS RELATING TO TURBINES, Matthew Bell, 73, Herrington-street, Sunderland.

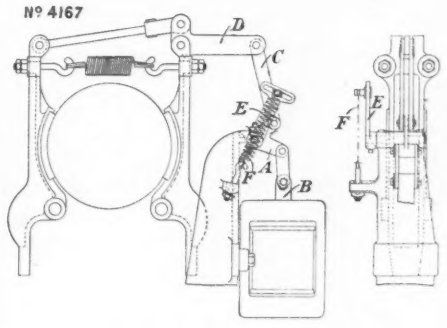
The turbines dealt with in this specification are of the combined impulse and reaction type, and the improvements described relate to the axial balancing of the shaft. From the impulse end of the turbine a pipe A is led to a chamber B, wherein dummies C on the stator engage with dummies D on the turbine shaft. If the shaft moves axially so as to leave too much space between the dummies



C and D more steam will escape from the chamber B into the exhaust than enters it by way of the pipe A. The pressure in the chamber B therefore falls, and as a result the shaft is pushed back to its former position. If the dummies are too close the reverse action takes place. The equilibrium position is that in which as much steam is entering the chamber B by way of the pipe A as is escaping past the dummies to the exhaust. A valve may be applied to the pipe A to regulate the flow of steam through it.—*November 22nd*, 1911.

CRANES AND CONVEYORS.

4167. February 18th, 1911.—IMPROVEMENTS IN THE BRAKE MECHANISM OF LIFTS, CRANES, AND THE LIKE, B. P. Walker and R. Waygood and Co., Limited, both of Falmouth-road, Great Dover-street, London, S.E.



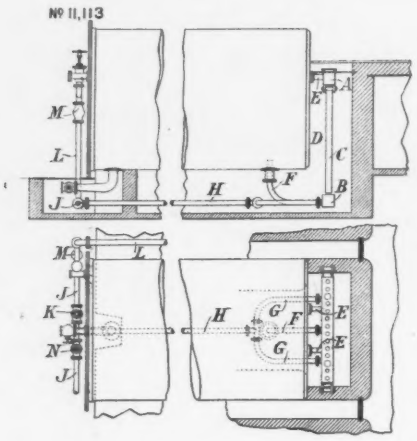
From one arm of a bell-crank lever A the plunger B of an electro-magnet depends. The other arm of the bell-crank lever is linked as at C to the lever D, which lever operates the usual brake

mechanism. Attached to the shaft on which the bell-crank lever A is mounted is a slotted arm E. A spring F is attached as shown to the arm E. As the line of action of the force of this spring passes through the centre of the shaft on which the bell-crank lever is mounted it will be seen that the spring F holds the bell-crank lever to either side, according as it is moved. So long as the magnet is energised the plunger B is in its upper position and the brakes are held off. When the magnet is de-energised the weight of the falling plunger pulls the bell-crank lever down and allows the brakes to act.—*November 22nd*, 1911.

CONDENSERS AND FEED-WATER HEATERS.

11,113. May 8th, 1911.—IMPROVEMENTS IN FEED-WATER HEATERS AND BOILER CIRCULATORS, F. W. Green, of E. Green and Son, Limited, Fuel Economiser Works, Wakefield, Yorkshire, and Harry Slade, of the same address.

The feed-water heater, consisting of the usual cross boxes A B and connecting tubes C, is situated in the flue D. The top box A is connected by pipes E E to the boiler below the low-water level. The bottom box B is joined to the bottom of the boiler by a pipe F. Branch pipes G uniting into a single pipe H are also connected to the bottom box B. The pipe H passes to the front of the boiler where it joins a branch pipe J. This branch pipe on one side is

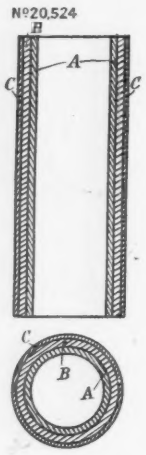


provided with a check valve K, and is connected with the feed-water pipe L. M is the feed-water stop valve. The other end of the branch pipe J is provided with a blow-off valve N. With the feed-water valve M turned on the water flows into the bottom box B, up those of the tubes C which lie nearest either end, through the tubes E, and into the boiler. At the same time hot water leaving the boiler by the pipe F flows into the bottom header, up the inner tubes C, and back into the boiler. Thus circulation and feed heating proceed simultaneously. The circulation goes on, however, even although the valve M is shut and the feed stopped. The heater can never become short of water, nor can steam enter it, except for blowing off purposes.—*November 22nd*, 1911.

TRANSFORMERS.

20,524. September 11th, 1911.—IMPROVEMENTS RELATING TO TRANSFORMERS, *Emil Haefeley, of 29, Budesstrasse, Basle, Switzerland.*

This invention relates to an insulating sleeve especially suitable for oil transformers that are exposed to high electro-motive forces wherein the insulating material of which the sleeve is composed is not homogeneous in the direction of its thickness, but consists of a number of layers, that is to say, of at least one hard layer A, which is capable of giving mechanical rigidity to the sleeve and one soft layer B consisting of an absorbent or suction-producing material

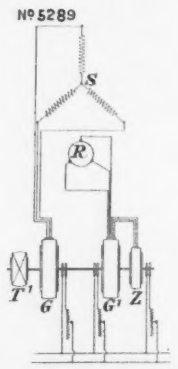


which becomes saturated with the oil in the transformer and which serves mainly to fulfil the insulating function of the sleeve. The hard covering C may be cut away in the well-known manner at the top and bottom to about the extent to which it is intended that the sleeve should project beyond the high-tension winding, which is assumed to be on the outside; under these circumstances the surface of the uncovered part of the layer which projects beyond the winding and is saturated with oil, is in direct contact with the oil which surrounds the sleeve when in use in the transformer.—*November 22nd*, 1911.

DYNAMOS AND MOTORS.

5289. March 2nd, 1911.—IMPROVEMENTS IN AND RELATING TO THE CONTROL OF ELECTRIC MOTORS, the British Thomson-Houston Company, 83, Cannon-street, E.C.

The scheme described in this specification is suitable for the control of motors used for ship propulsion. It is also applicable to other purposes, such as winding systems, rolling mills, &c. In the drawing T^1 represents a turbine or other prime mover which drives two alternating current generators G and G^1, one of which supplies current to the stator S, and the other to the rotor R of an alternating current commutator motor. A booster Z is connected in series with the generator G^1, the neutral or star point of this generator being opened. The booster may also be an alternating current generator, the field winding or stator of which is, however,

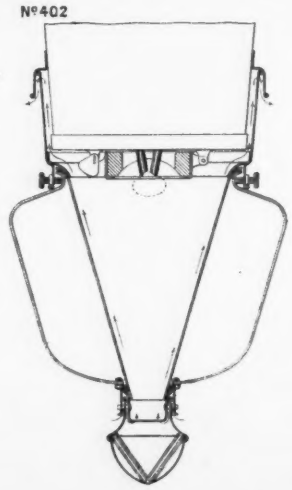


displaced as regards the corresponding parts of the generator G^1 in such a manner that the voltages produced in the series windings of G^1 and Z are relatively displaced in phase. A regulating resistance is inserted in the field magnet circuit of each of the three generators, and by it the voltage of the machine, and consequently, the speed of the commutator motor, can be regulated.—*November 22nd*, 1911.

LIGHTING AND HEATING.

402. January 6th, 1911.—IMPROVEMENTS IN LAMP GLOBES, PARTICULARLY FOR ELECTRIC ARC LAMPS, Johnson and Phillips, of 14, Union-court, Old Broad-street, and James Brockie, of 41, London-road, Forest Hill.

The primary object of this invention is to extend the area of effective illumination of electric arc lamps of the open type. Another, but entirely subsidiary, object is to prevent the condensation of products of combustion of the arc or other source of

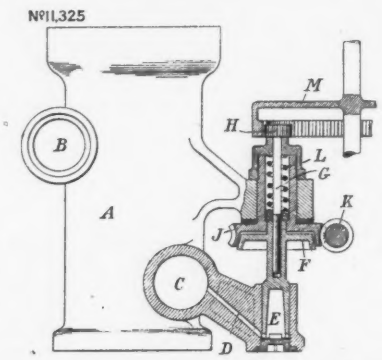


light upon the inner surface of the globe and, in general, to keep the surfaces of the glass through which the light is transmitted clean and bright. The globe comprises an inner member of glass which is open to the passage of air, and the walls of which slope downwardly and inwardly so as by reflection to disperse the light emitted from the source. The outer glass globe encircles the inner member so as to form an air jacket around it. The inner member consists of the frustum of an inverted cone having an apex angle of the order of 30 deg. to 40 deg.—*November 22nd*, 1911.

ORDNANCE AND ARMOUR.

11,325. May 10th, 1911.—IMPROVEMENTS IN AUTOMOBILE TORPEDOES, Eugene Schneider, of Le Creusot, Saône-et-Loire, France.

As is well known, automobile torpedoes are arranged to stop after a given run, and thus a torpedo which has missed its mark is caused to rise. This invention deals with the stopping device.



A is the starting valve, whereby communication between the air reservoirs and the engines is controlled. B and C are the inlet and outlet ports respectively. From the port C a passage D leads into a small cylinder, wherein a piston E can slide. This piston is extended upwards in the form of a coned clutch member F. A square rod G fits within a square hole in the clutch head, and carries at its top a small pinion H. The other clutch member J is driven by a worm K from the torpedo engine, and contains a spring L, tending to force the clutch member F out of engagement. When the torpedo is started, the pressure of air within the small cylinder forces the clutch members into engagement. The motion of the worm K is thus transmitted to the pinion H. This pinion operates a part M of any suitable mechanism which will close the admission valve after the engine has made a predetermined number of revolutions.—*November 22nd*, 1911.

MINES AND METALS.

16,294. July 14th, 1911.—AN IMPROVED PROCESS FOR COATING IRON OR STEEL, A. J. Michelin, 105, Boulevard Pereire, Paris.

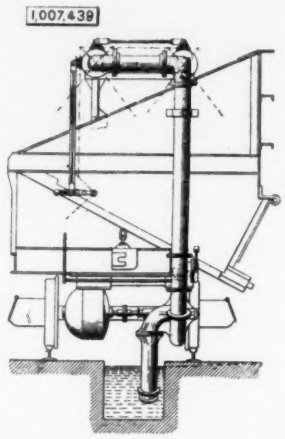
The article to be coated is first cleaned with acid and washed with water. Thereafter it is heated in a receiver in contact with a fine powder composed of oxide of zinc (commercial zinc white) 80 parts, dry carbonate of potash 12 parts, and wood charcoal 24 parts. The temperature to which the receiver is brought should be less than the point of volatilisation of the zinc. The presence of the alkaline carbonate lowers the temperature required for the process.—*November 22nd*, 1911.

SELECTED AMERICAN PATENTS.

(From the United States Patent-office Official Gazette.)

1,007,439. DEVICE FOR QUENCHING COKE, *L. C. Flaveus, New York, N.Y., assignor to Stettiner Chamotte-Fabrik Actien-Gesellschaft corm. Didier, Stettin, Germany, a Corporation of Germany.—Filed January 14th*, 1911.

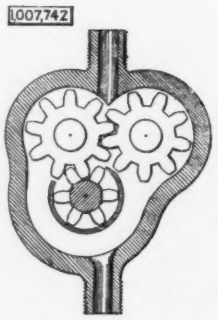
This patent is for the combination with a track and a car



arranged to travel thereon, of a plurality of spraying pipes carried by the car and mounted to turn about different axes, means for supplying water to the pipes, and means for rocking the pipes in unison. There is only one claim.

1,007,742. ROTARY PUMP FOR MACHINE TOOLS AND OTHER PURPOSES, *J. Smith, Birmingham, England.—Filed August 25th*, 1911.

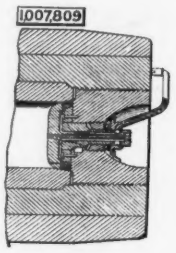
This invention consists in the combination of a casing, an inlet, an outlet, a pair of intermeshing pumping wheels located between



the inlet and outlet, a driving wheel meshing with one of the pumping wheels, and means for shielding this driving wheel from the pressure caused by the force of the current; substantially as set forth. There are four claims.

1,007,809. ORDNANCE, *W. D. Smith, Denver, Colo., assignor to Automatic Flareback Prevention Company, Pittsburgh, Pa., a Corporation of New Jersey. Original application filed May 11th*, 1906. *Divided and this application filed January 4th*, 1909.

This patent is for introducing water under pressure at the breech



to stop flame. The claims are for a mushroom head, a fluid chamber behind the mushroom head, and means for automatically supplying fluid to chamber by closing the breech of the gun to cushion the rearward movement of the mushroom head when the explosion takes place. There are nineteen claims.

SOME IMPRESSIONS OF CONTINENTAL MARINE DIESEL ENGINE PRACTICE.

No. III.*

WE believe we are right in saying that the famous steam engine makers, Sulzer Bros., of Winterthur, were the first seriously to take up the construction of Diesel engines for marine purposes, a four-cycle engine with electric transmission having been built by them in 1904 and fitted on a cargo boat on Lake Geneva, from which much useful information was derived. Two years later—1906—their first reversible engine, Fig. 1, was exhibited at Milan, and this engine was also fitted on a boat on Lake Geneva and submitted to exhaustive tests. Since that date, however, much water has flowed under London Bridge and many marine engines have been built, each embodying the result of experience and each marking a step in advance, till an engine was designed for use on submarines which comes very near our present ideal of what such an engine should be, and embodies all the requirements which we have from time to time suggested should be found in a marine engine, with the exception of the short piston, piston-rod, and crosshead. Those omissions, however, are rendered necessary by the extremely confined space into which the engines have to be fitted. The engine—Fig. 3—has six cylinders working on the two-cycle, and gives 300 brake horse-power at 500 revolutions per minute. It has scavenging and compressed air pumps at the forward end of the crank shaft. The cam shaft is driven by what may be stated to be standard practice—a vertical skew-gear driven shaft—and it runs along the top of the engine in the usual position, just clear of the covers. After these, so to speak, standard outlines, points of interest immediately appear in the design. The scavenging air valve, instead of being in the head, is placed at the bottom of the cylinder and inside the scavenging air pipe, directly below the cam shaft; thus, by means of an ordinary tappet, the valve is operated directly by the cam without the intervention of a rocker—quite a useful simplification. It might be thought that the admission of the scavenging air at the bottom instead of at the top of the cylinder, as is usual, would lead to some slight decrease in the completeness of the scavenge in spite of a baffle on the piston. Repeated experiments have shown that this is not so, and that the efficiency remains the same; even if it were not so the simplification which results would probably be well worth a slight difference in efficiency, at any rate for engines where maximum efficiency is not of supreme importance. There are thus only the fuel and the compressed-air starting valves in the cylinder head, each having its own small rocker, while the cams—three to each cylinder—are enclosed and run in oil, a most desirable practice, and one which results in the abolition of a lot of noise; in this engine, in fact, the valve gear was remarkably silent, 90 per cent. of the whole of the noise made at full speed being apparently due to the air compressors.

For submarine purposes, where, as we have pointed out, head room is extremely limited, there is a reasonable justification for the use of the trunk piston, and a very nice design is arrived at by supporting the cylinders on steel columns with diagonal stays, exactly as is done in high-speed steam engine practice, though as forced lubrication is used throughout, that is, up to the gudgeon pin, the whole of the lower part of the engines below the cylinders is cased in by light wrought iron plates, which are easily removable and allow the piston to be completely withdrawn from below in a very short time. For the sake of lightness the bed-plate is of bronze, while aluminium is used to a surprising extent for doors, &c. The fly-wheel is quite small in diameter—indeed, with the six impulses per revolution it might have been entirely dispensed with, as is done in the M.A.N. engines.

The strong point of the two-cycle engine is again evidenced in the great simplicity of the reversing arrangements, and, though there are three small levers to be handled in this case, it is difficult to say that they are much less simple than those of the Nürnberg engines. As the ordinary non-scavenged two-cycle engine will continue running in the direction in which it is started, the reverse in this direction will then only have to depend on the compressed air valve to start it in the right direction and the correct setting of the fuel and scavenging valves to keep it so. The cam rollers of the two latter are suspended on a link connected up to what may be called the weigh shaft, and by this they are shifted across from one side of the centre of the cam to the other by the movement of one of the small levers mentioned, as can be seen at *b* in the drawing of the Romagna's engines, Fig. 5. The second lever puts the fuel valve out of action, and the compressed air valves into action, the cams ensuring the admission of the air only to those cylinders of which the cranks are in the position to give motion in the required direction. When the engine has been started on air this second lever is moved to the opposite side of its quadrant and the air is then replaced by oil. We must say we prefer some arrangement whereby some of the cylinders are started up on the oil while the air is still being admitted to the remainder, and we understand that this will be done in future, an intermediate position admitting oil to two cylinders only, the other two remaining on air, as indicated in Fig. 7. The third little lever is the usual throttle to control the speed by varying the supply of oil to the pump. We were not able to see this engine manœuvred, so cannot say anything as to the promptness or certainty with which the arrangement works, but it certainly looked simple enough. It should be said that the amount of air as well as that of the fuel is under control, which leads to complete combustion and to smokelessness at all speeds. As to the latter, we can speak from our own observation on large units in electric generating stations.

In Fig. 4 we show the Italian mail boat Romagna, which has just been fitted with two sets of 800 combined horse-power engines on the same general lines but running only at 250 revolutions per minute. The boat was built at Ancona for the Ravenna, Trieste and Fiume service and has a speed of 12 knots. She is 175ft. in length by 25ft.

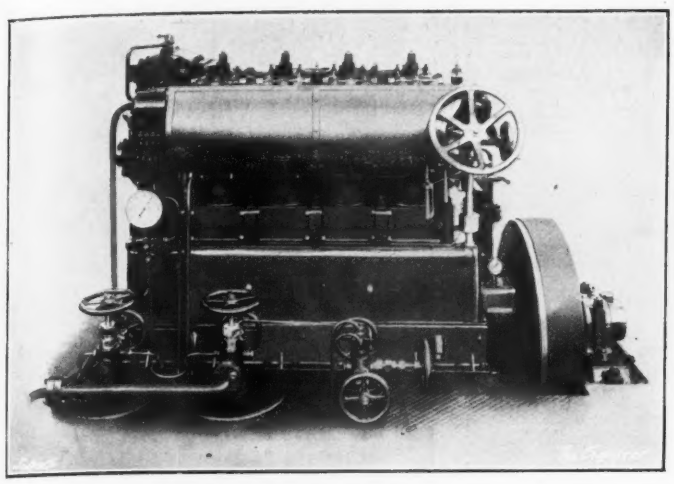


Fig. 1—FIRST SULZER REVERSING ENGINE

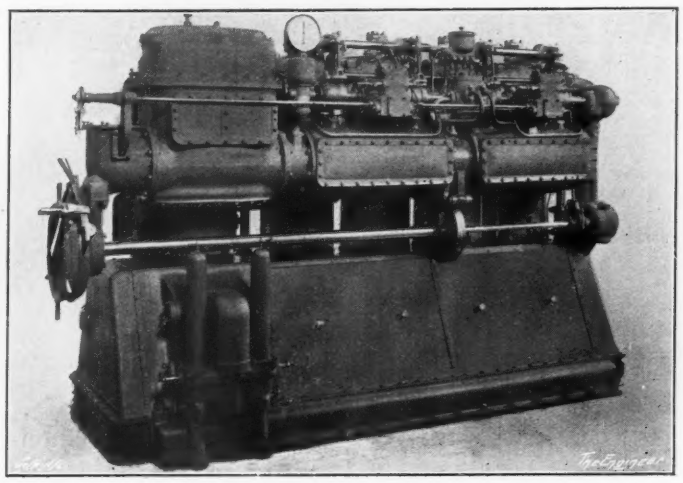


Fig. 2—ENGINES OF THE ROMAGNA

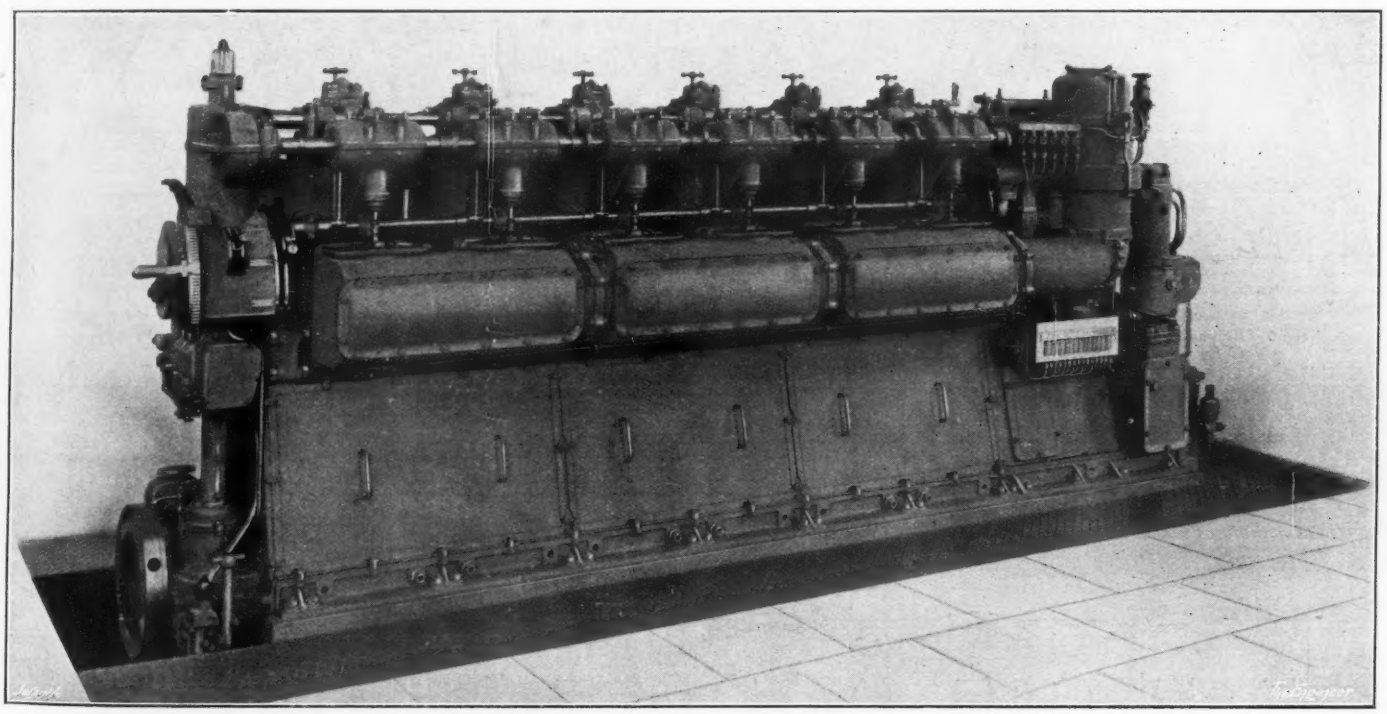


Fig. 3—SULZER SIX CYLINDER MARINE ENGINE

* No. II. appeared December 15th.

DIESEL ENGINES FOR MARINE PROPULSION

(For description see page 629)

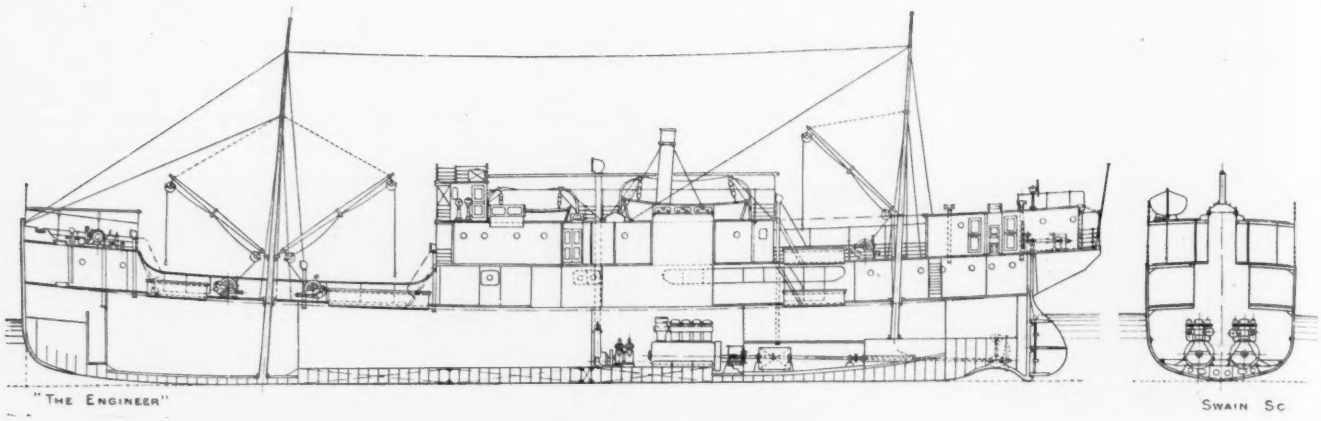


Fig. 4—TWIN-SCREW OIL-SHIP ROMAGNA

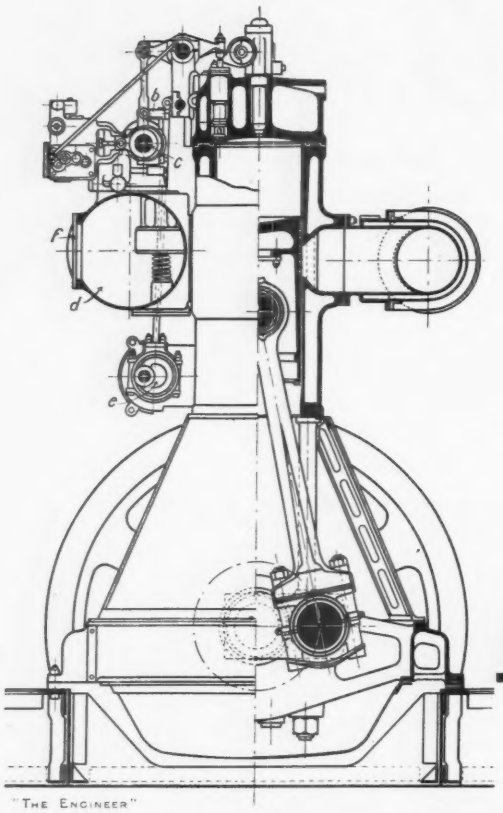


Fig. 5—ENGINES OF THE ROMAGNA

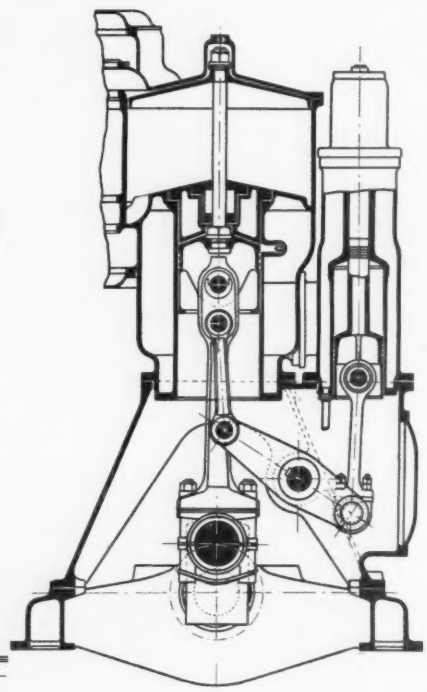


Fig. 6—SCAVENGING PUMP AND AIR COMPRESSOR

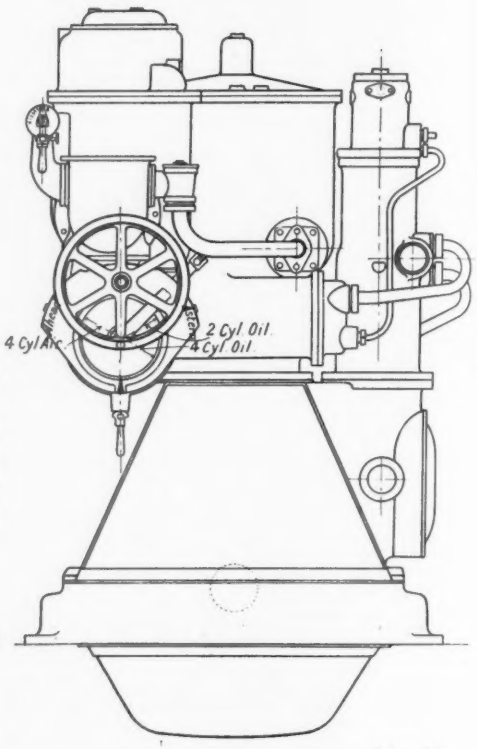


Fig. 7—MANŒUVRING GEAR, ETC.

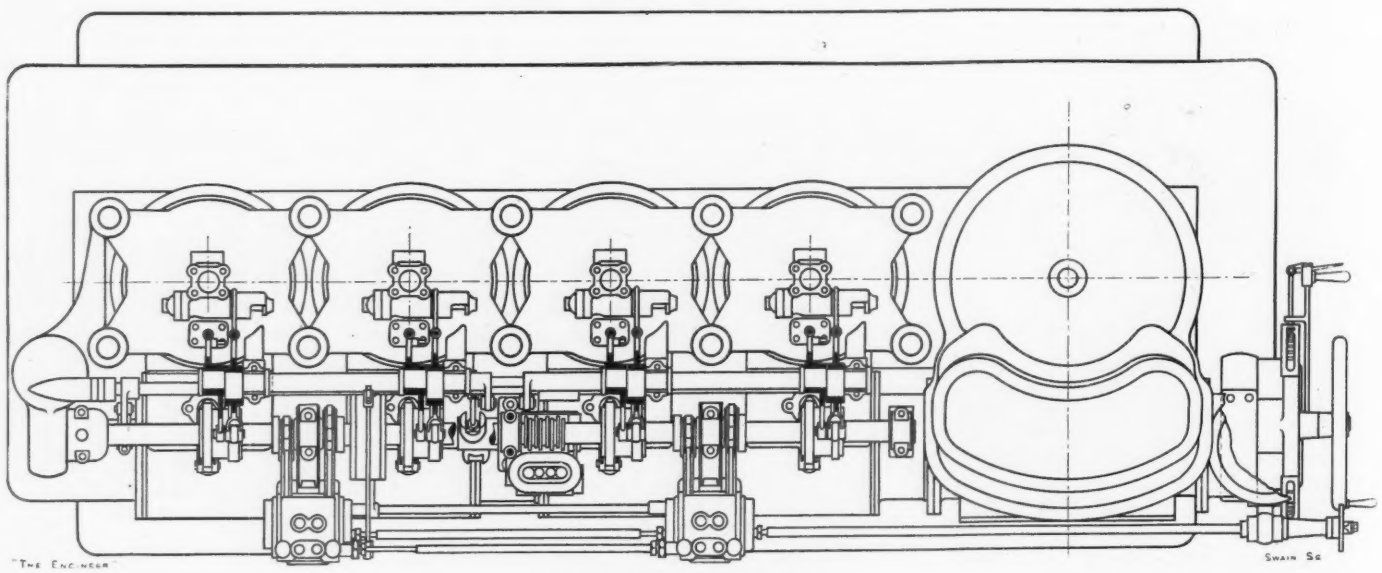


Fig. 8—ENGINES OF THE ROMAGNA

beam and 12.6ft. depth, and on a displacement of 1000 tons has accommodation for 25 first-class and 30 second-class passengers and some cargo, while a very good idea of the compactness of the machinery may be gained from the illustration. The engines themselves are shown

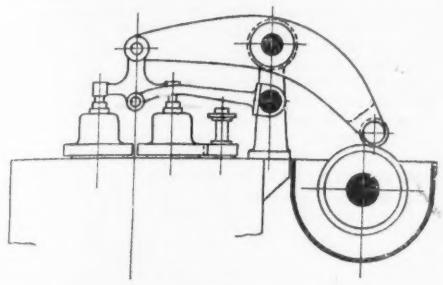


Fig. 9

in Fig. 2. In this case the scavenging air valves are also in the air passage *d*, Fig. 5, but they consist of piston valves, instead of tappet valves, and are driven by small excentrics *e* on a special shaft, an arrangement which

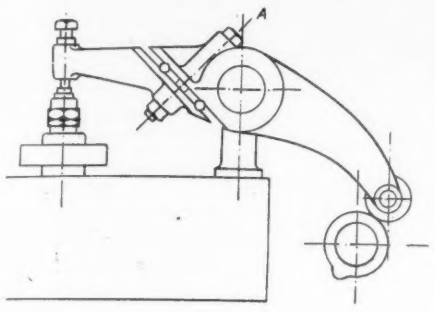


Fig. 10

should tend to still greater silence. Access to these valves is obtained through the door *f*, shown along the air casing in front of the engine. The links for moving the cam rollers from side to side of the cams for reversing are shown at *b*. The double-acting scavenger pump and air compressors can be seen at the forward end of the engine in Figs. 2 and 8. In later designs, however, they will be arranged as shown in section in Fig. 6, where the crosshead of the scavenging air pump acts as the first stage piston of the air compressor, the second and third stage compressors being in tandem and driven off the crosshead by rocking levers, a nice arrangement which is not only cheap to construct, but one that provides for a balance of the reciprocating parts to a certain extent and saves space fore and aft. We understand that on trial the Romagna did 12.4 knots, and that the manœuvring test consisting of twenty-five reversals from full ahead to full astern and *vice versâ* in twenty-five minutes, were satisfactorily carried out. We are also informed that in heavy seas the engines have proved to be under the complete control of the governor even though at full speed. A further point noted in the trials is the freshness of the atmosphere in the engine-room, owing to the circulation set up by the suction of the air pumps. This point, it will be remembered, we commented on in the case of the Vulcanus, and some plan of warming the engine-room will undoubtedly have to be adopted in all such cases when the ship is not required for tropical countries.

In addition to the marine engines we were shown a four-cylinder vertical two-cycle set for driving a generator giving 2400 horse-power at 156 revolutions per minute—page 640. It was running on the test bench, if we may use

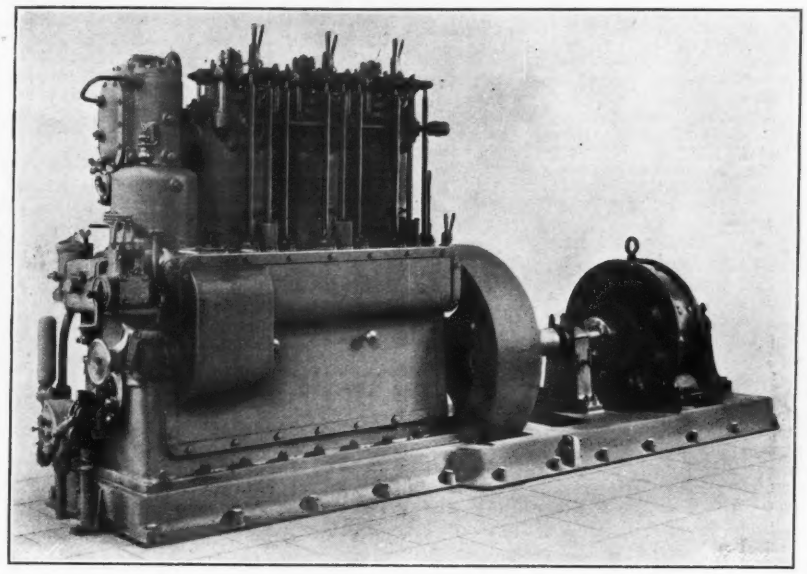
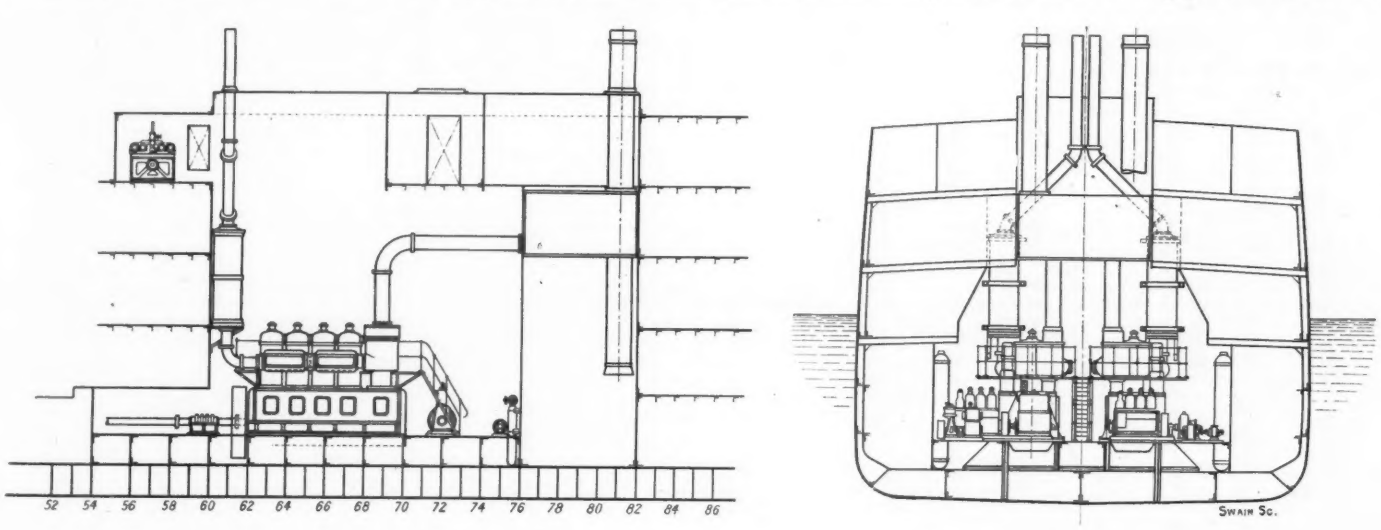


Fig. 11—35 HORSE-POWER GENERATOR SET

the word of so big a construction. All Diesel engines at the present time, especially those of the largest powers, require to be run on full load before leaving the shops, in order to get the fuel valve cam set exactly right for correct combustion, and this is one small contribution to the higher cost of these engines as compared with steam. That this addition is not negligible will be realised when it is remembered that very substantial test beds and foundations have to be provided for trying engines; that complete water circulating and exhaust pipes have to be made, a powerful brake fitted up and a lot of labour and fuel expended; the capital outlay is increased owing to the fact that arrangements have to be made for testing a number of engines at the same time. We were very much interested to note that three out of the five firms dealt with in this article use the Froude water dynamometer made by Heenan and Froude, Limited, of Manchester.

The design of the generating sets varies somewhat from those which have been described above; the cylinder is cast solid with its two supports, and the space between the columns is cased in by planished steel plates. Thus access to the piston has to be obtained by the removal of a cylinder cover, attached to which are the scavenging valves, the fuel and air valves, and their respective rockers, so that there is the main cover joint to be broken, the scavenging air pipe joint, and sundry smaller pipes, and the job would probably take longer than could be allowed at sea. The four scavenging valves in each cylinder are arranged in pairs connected together by a yoke to which the rocker is attached, Fig. 9. These rockers are in most cases constructed as in Fig. 10, so that, by the removal of one bolt A, and the bolts of the valve-cage flange, the valves can be taken out without removing the whole rocker and its attachment to the cylinder. The cams run in an oil bath, and we were particularly well enabled here to judge of the silencing effect. A hinged cover goes over the top of them and surrounds the ends of the rockers, so that oil is not splashed about, but access for examination is instantaneous. We also saw a three-cylinder engine of 750 horse-power of this type which had been at work for three years in a power station at Asraw, and a four-



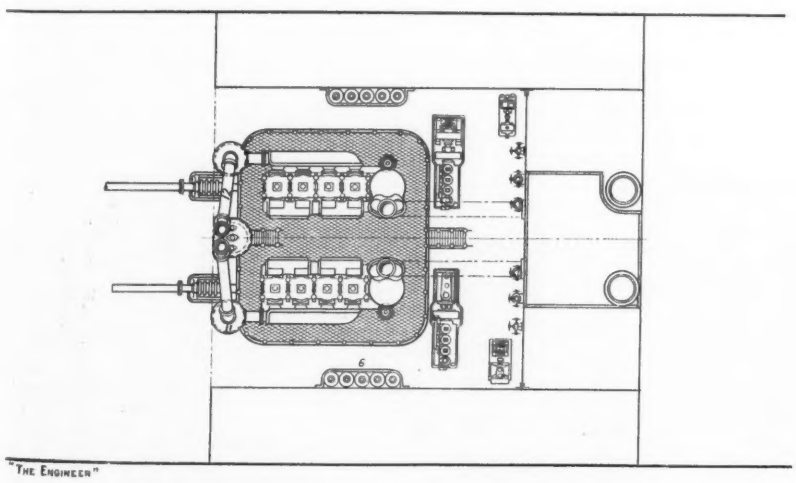


Fig. 12—ENGINE-ROOM ARRANGEMENT, 1600 COMBINED HORSE-POWER

cylinder one of 1000 horse-power which had been at work for ten months on the same service at Liestal, both of which we learned from the engineer in charge have been giving every satisfaction, and there appears to have been no clogging of the rings with the Galician oil used. We were informed that the average consumption in the latter case for the varying loads to which such engines are subjected has come out at about 0.49 lb. per horse power per hour for the whole period, the oil costing about 44s. per ton. Though, of course, water power is very largely used for generating purposes in Switzerland, we were interested to find that the universal drought experienced this summer has had a quite appreciable effect in stimulating the demand for Diesel engines to take the peak of the load.

We came away from the works of Messrs. Sulzer Brothers with a mental impression that it is here that the biggest jobs are more or less ordinary practice, that is as far as vertical engines are concerned—the M.A.N. are building plenty of big horizontals—we were, in fact, shown the bed-plate and crank shaft of a single-cylinder vertical experimental motor which is expected to give 2000 horse-power on the brake, and the makers have every confidence that this will be obtained without any serious difficulty. On the other hand, we were shown a very nice little three-cylinder four-cycle Diesel engine for auxiliary purposes—Fig. 11—giving only 35 horse-power at 450 revolutions per minute, with the cam shaft below the cylinders and driven direct off the crank shaft by spur gearing, as in the Normand engine. Two of these have been supplied for lightships to supply current for the light and air for the fog horns. Except for the last-named all the above were on the two-stroke cycle, but engines up to about 800 horse-power are being built on the four-stroke cycle, and from what we saw of the running of the various engines we certainly think that the latter are very considerably quieter than the two-cycle. This is rather curious, as it was not a question of valve speed, since the four-cycle engines were running at about double the speed of the two-cycle. As regards vibration we had not a fair opportunity of judging, though we were informed that a four-cycle set, specially designed for ship lighting, had actually been run with no holding down bolts at all. Finally, we were courteously provided with the engine-room arrangements of one of the big twin-screw steamers now under construction for the Hamburg-South America Line, reproduced in Fig. 12. The compactness of these two sets of 800 B.H.P. each is well shown—the auxiliaries consisting only of an air compressor engine and a dynamo engine, the deck machinery being driven by a donkey boiler.

ERRATUM.—Page 612, second column, sixth line, first word, for angles read angle ϵ.

THE BATTLE OF THE SUPERHEATS.

By ROBERT H. SMITH.

IT may be remembered that diagrams giving the results of the researches upon the varying values of the specific heat of superheated steam carried out a few years ago in the Münich Technical College by Messrs. Knoblauch and Jacob have been published in these columns—see THE ENGINEER, 13th August, 1907.

This investigation was carried up to a pressure of 8 atmospheres and 350 deg. Cent. Since then it has been extended up to 550 deg. Cent., with the same pressure limit by Mr. Knoblauch,* with the assistance of Miss Mollier, a student whose father's work in the domain of scientific steam engineering is wor d-famous. The research apparatus has been improved in detail, but remains the same in all essential principles. The old ground has been gone over again in outline, and has substantially confirmed the consistency between the old and the new results. A further extension of the range of the

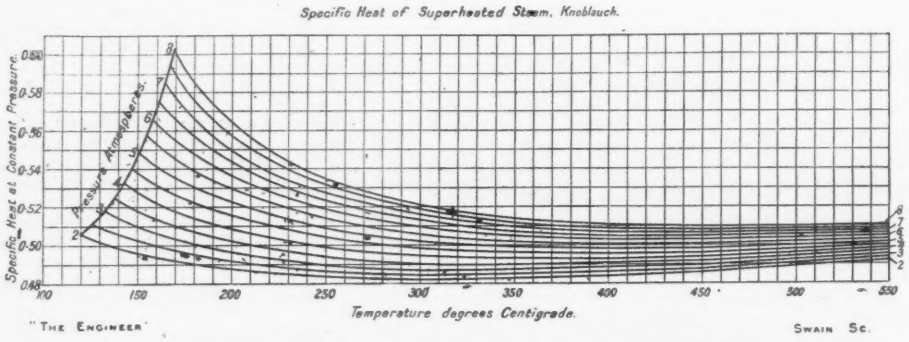


Fig. 1—KNOBLAUCH'S DIAGRAM OF THE SPECIFIC HEAT OF SUPERHEATED STEAM

measurements up to 20 atmospheres pressure and 350 deg. Cent. is now proceeding.

Fig. 1 is a reproduction of Knoblauch's new diagram giving the results as obtained up to this date. Each of the curves is for one given pressure. The horizontal scale is Cent. temperature; the vertical heights are the mean specific heats, the mean being the arithmetic mean over the temperature range of each individual measurement, which range averaged about 46 deg. Cent.

In spite of the refinements in the methods of experimentation adopted, and the extreme care used in every stage of each test, the correctness of these results is now challenged, even as to the general shape of the sheaf of curves upon this diagram.

The challenge comes from Liège University, the home of Professor Dwelshauvers-Dery, whose renown as an investigator of engineering physics is familiar to every scientist. The challenge is made by the successor to Dwelshauvers-Dery in the Liège Chair of Engineering, namely, Professor Armand Duchesne.

Fig. 2 is a reproduction upon a reduced scale of Duchesne's diagram of specific heats. The ordinates are temperatures Cent. and mean specific heats, the same as those in Knoblauch's; and each curve, again, is for one given pressure. In the Knoblauch diagram the curves are for every atmosphere of pressure from 2 to 8. In the Duchesne diagram they are for the pressures 1, 2, 3, 4, 5, 10, 15, and 20 atmospheres. In each diagram the group of curves is stopped off at the left hand end at the "saturation curve"—that is, the curve co-ordinating with the temperature, the specific heats of steam as it is heated above and immediately close to the condition of saturation. In each the specific heat at "constant pressure" is given in diagrammatic form.

The general characters of the two diagrams are utterly different. The shapes of the individual curves in the two have no resemblance or similarity. According to Knoblauch, the specific heat increases with the pressure

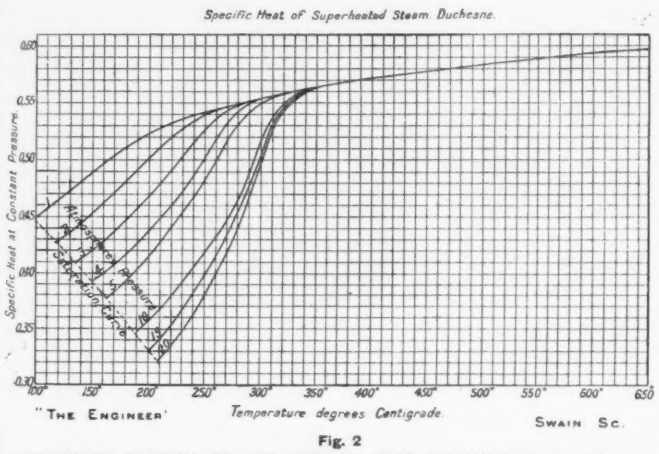


Fig. 2

DUCHESNE'S DIAGRAM OF THE SPECIFIC HEAT OF SUPERHEATED STEAM

throughout the whole range of temperature; according to Duchesne it decreases as the pressure rises up to about 350 deg. Cent., beyond which there is no variation with pressure. Even the limiting curve of saturation has a totally different run in the two diagrams; it curves upwards steeply with increasing temperature, *à la* Knoblauch; it takes a straight line downward course *à la* Duchesne.

At 550 deg. Cent. Duchesne's single value is 0.59; at this temperature Knoblauch's values range from 0.49 to 0.51 and average 0.50. At 350 deg. Cent. the single Duchesne value is 0.565; and here the Knoblauch value ranges from 0.485 to 0.515. At saturation Duchesne gives 0.43 for 2 atmospheres, and 0.355 for 8 atmospheres; while Knoblauch gives 0.505 for 2 and 0.605 for 8 atmospheres.

These differences are far beyond the limits of possible errors of observation in such careful research, and they are fairly regular over the whole scope of the research, whereas errors of observation are always more or less irregular. The differences are due to different methods of investigation and differences in the measuring instruments employed.

The two sets of results cannot both be correct; one may be right and the other wrong, or the truth may lie somewhere between the two.

Professor Duchesne explains his conviction that the differences between these results are due to errors in the indications of steam temperatures given by mercurial thermometers set in metal pockets in the path of the steam flow. As the bulb of the thermometer cannot make direct effective heat-conductive contact with the interior of the pockets, which are constructed of short lengths of tube, these pockets are usually filled with oil into which the thermometer dips. The heat has then to be transmitted (1) through the steel or other metal of the pocket-tube, (2) through the oil, and (3) through the glass of the thermometer bulb, before it reaches the mercury; and consequently there are (*a*) a want of sensitiveness in the quick indication of small changes of temperature in the steam, and (*b*) a defect in the true indication owing to part of the heat being conducted along, instead of through, the metal and oil, and being thus dissipated and never reaching the mercury. It may be mentioned that these defects of mercury thermometers in oil-bath pockets are fully recognised by other experimenters. The present writer has very greatly improved the sensitiveness of the arrangement by perforating the necessarily strong steel tube which forms the pocket with a large number of small holes, and covering these with a very thin external envelope or sheet of copper brazed on; and then employing fine copper dust instead of oil to fill the pocket and produce full and close contact with the thermometer bulb.

Professor Duchesne has therefore designed and used in his superheat investigation what he calls a hyperthermometer, which is a thermo-electric pyrometer of hyper or extreme sensitiveness, and which he claims to be the only reliable means of measuring the true mean temperature of a mass of highly superheated steam or of hot gas. It consists of a network of excessively fine silver and platinum wires which are stretched in a regular pattern through the steam space whose temperature is to be measured, and are brazed to two stout wires of the same metals, which form, so to speak, the frame of the network, and are at the same time the leads to the bath of melting ice which fixes the temperature of the cold junction of the thermo-electric pile. The fine wires having only about $\frac{1}{1500}$in. diameter, the network composed of them has only a very minute thermal capacity, and this hyper-thermometer responds practically instantaneously to extremely small changes in the temperature of the steam surrounding it. The instrument was calibrated by a laborious method, for the details of which we must refer interested readers to Professor Duchesne's volume published this year by Dunot and Pinat, Paris,† only mentioning here that the method of calibrations seems to be entirely satisfactory, and that the instrument is not only extremely delicate, but also thoroughly trustworthy in the truth of its indications when used with proper skill. The differences between its readings and those of the best mercurial thermometers—after the application to the readings of the "Thorpe" correction—are practically zero when both are placed in saturated steam or other vapour, the condensation on the pocket or bulb of the ordinary thermometer leading to rapid heat supply that prevents any appreciable error. But as the temperature rises further above saturation temperature, the error under the conditions of Professor Duchesne's tests reaches the enormous amount of 85 deg. Cent. It increases with the temperature and decreases with the pressure; or expressed more shortly, it increases with the volume or diminution of density. The above 85 deg. Cent. error occurs with 1.7 atmos. pressure and 173 deg. Cent. superheat; it is about 43 deg. Cent. with 6.7 atmos. pressure and 98 deg. Cent. superheat. These errors are so alarmingly large that Professor Duchesne devotes quite a large section of his volume to detailing the tests whereby he proves them to be real, and giving full tables and diagrams of all or most of his test measurements. We certainly think he has made out his case against the reliability of mercurial thermometers when used in hot gas or highly superheated vapours.

But it so happens that Knoblauch's results do not depend upon any readings of mercurial thermometers. He finds the specific heat by supplying definite quantities of electrically generated heat, and measuring the consequent rise of temperature by a differential thermo-electric pyrometer, the elements of which are steel and constantine. These elements are not the same as those used by Duchesne, and he does not use a network of many extremely fine wires, but uses a single junction at each place whose temperature is to be measured; but for the purpose in view his temperature measuring instruments are equally reliable and almost equally sensitive as those of Duchesne; there cannot be any important difference in their results arising from errors in temperature measurements. There may be slight errors in the Knoblauch measurements due to the pyrometer blocking the steam passage way through the tube, thus raising considerably the velocity of the steam at this point, and slightly reducing its pressure and temperature, an error, however, either partially, or perhaps wholly, counterbalanced by the heating of the pyrometer due to the mechanical beating of the high velocity steam upon its surface. But such possible errors are of very small and unimportant amount.

The two experimenters' methods of measuring the weights of steam heated are practically the same, and we may credit them with equal skill in avoiding error in this much more simple and easy element in the investigation.

Unfortunately, in all these experiments a very large proportion of the heat supply is wasted by external radiation and convection from the outside surfaces of the apparatus. In both the Münich and the Liège Laboratories this waste was measured by nearly the same method, namely, immediately after the conclusion of each main test in which steam was superheated, the flow of steam was stopped, but the supply of heat continued so as to keep the whole apparatus in all its parts steadily at the same temperatures as those during the previous passage of steam. This supply of heat is taken as equal to the waste of heat; and deducting it from the heat supplied during the passage of steam, the remainder is taken as that conducted to the steam, and from it the specific heat is calculated. In spite of the most elaborate precautions

* "Die spezifische Wärme des überhitzten Wasserdampfes für Drücke von 2 bis 8 kg/qcm. und Temperaturn von 250 bis 550 deg. Cent." von Oskar Knoblauch und Hilde Mollier.

† "Recherches sur les Propriétés de la Vapeur d'Eau Surchauffée," par Armand Duchesne.

against external heat waste, it was in Knoblauch's apparatus about 33 per cent. of the whole heat supplied to raise the superheat by about 40 deg. or 50 deg. Cent. In the single numerical example given by Duchesne of his calculations of this quantity, it was 4½ per cent. of a very much larger figure, namely, the total heat of the steam from water at 0 deg. Cent. This means a ratio of loss about 3½ times greater than in Knoblauch's apparatus; and the constructive differences between the two would lead one to expect greater losses in Duchesne's than in Knoblauch's. This large proportion of waste in both cases, however carefully they were measured and allowed for, of course, diminishes greatly the degree of reliable accuracy attributable to these investigations. At the same time it illustrates the very great difficulty of the investigation from the physical laboratory point of view, and also increases the merit and honour due to those who have undertaken such laborious work in the interests of engineering science.

The great difference in the two methods of procedure lies in the modes of measuring quantities of heat and in the heat quantities chosen for measurement.

Both experimenters raise their steam to about the superheat desired for each individual test by very much the same means, and both make sure that it does not contain any water in cloud or other form. Herein there is nothing to choose between them.

Knoblauch now supplies to this steam a further quantity of heat generated electrically by passing the steam through a coiled tube in contact with an electrical resistance coil, in which the heat is generated. This quantity of heat can be measured with great accuracy by the common electrical means. He also measures electrically the steam temperature before and after it has received this heat, and, again, he measures separately and independently, and also electrically, the rise of temperature between these two. In each test this rise is limited to a fairly small range. By comparison of these measurements, and the weight of steam passed, he obtains a *direct* determination of the specific heat.

On the other hand, Duchesne measures in each individual test the total heat of the steam from 0 deg. Cent. water. For each constant pressure he deduces from these tests a curve of total heats. He now measures the slope of this curve—plotted upon a temperature base—at each point, and thus obtains the specific heat, or the increase of total heat per 1 deg. rise of temperature.

This is an *indirect* method of arriving at the final quantity; and, moreover, it is a method based upon small differences between large measured quantities. These small differences are the same—that is, should prove to be the same—as those measured directly by Knoblauch. In this comparison it is hardly needful to say that Knoblauch's method is the superior one.

Duchesne measures the total heat, not by the method of heating—he makes no measurement of heat supply—but by the method of cooling. From the test condition of superheat he leads his steam through a surface condenser cooled by a measured flow of cold water. The heat received by this cooling water is measured and is taken as equal to that lost by the steam in condensing, and by the condensed water in cooling down to the temperature of outflow from the condenser. Of course, as stated above, he measures the external loss of heat from the outside of this condenser. It is here to be observed that this condenser is a very large vessel, offering a very large external surface for the radiative and convective loss of heat, as compared with Knoblauch's vessel from whose external surface the heat waste is the measured loss. In spite of the much lower external temperature of the condenser the external heat waste to be measured in Duchesne's method is very much larger.

Again, during the measured heating process in Knoblauch's apparatus the steam expands only in an extremely small degree; the cross-section of the passage remains uniform, and the generation of velocity and of kinetic energy is minute, while in Knoblauch's calculation of results the effects of this small expansion are taken into account. But in Duchesne's apparatus the steam in the test-superheated condition is discharged from a drum of comparatively large diameter, where the velocity is almost nil and the pressure is high, through a very small pipe and valve into the condenser, where the pressure is hardly at all above the atmosphere. The discharge is therefore at a very high velocity, of the same order as that in impulse steam turbines. A large proportion of the heat energy in the steam is thus spent in the first place in doing work in the creation of kinetic energy—a proportion strictly comparable with the mechanical work done on the rotor of a single-stage impulse steam turbine, and, in fact, a larger proportion than this last. This kinetic energy is certainly destroyed once more in the condenser and during the condensation. It is probably wholly re-converted into heat before the condensation water issues from the condenser into the weight-measuring tank. Duchesne assumes that all the heat due to the re-conversion of this kinetic energy appears as heat in the condensing steam or in the condensed water, or at least is caught and measured in the cooling water flowing through the condenser. This is an assumption frequently made in physical researches upon the high-speed outflow of steam and gases, and is also made in the theory of many steam "wetness calorimeters"; but it has always seemed to us to be a very questionable assumption. A certain amount of the kinetic energy is certainly spent in the production of the hissing noise accompanying the high-speed outflow, and in the vibration which, although in special constructions may be of minute linear amplitude, is still always very intense. The kinetic energy is destroyed in large proportion by the impact of the high speed steam against the walls of bends and other obstacles, such as valves, interposed in its way; and in such impact surely as much or more energy is imparted to the solid parts impinged on—as on ill-set guide blades of a turbine—as goes towards the reheating of the slowed-down steam itself. The kinetic energy of high-speed outflow is again, in large proportion, firstly degenerated into eddy energy in the steam, in which form it is still kinetic energy and not heat, and only much later converted into heat by the rubbing down of these eddies into quietude; and this rubbing down is effected only in small part by the viscosity in the steam itself and almost wholly by friction against solid surfaces. Now this friction probably heats the solid surfaces quite as much as it heats the steam or water which loses the kinetic energy.

A measurement of a heat quantity which involves the assumption that all the kinetic energy of an extremely high-speed outflow from high pressure down to atmospheric pressure is recovered in the steam itself in the shape of heat therefore appears to us to be of doubtful accuracy; and we certainly prefer a procedure which avoids all large generation and destruction of kinetic energy inside those portions of the apparatus in which essential and basic measurements are made.

Once more it is to be noted that in Duchesne's method of research these kinetic energy effects are present during the main test measurements while the steam is passing, but are absent during the accessory tests to determine the external heat losses, which are made without any steam flow.

Moreover, we observe what appears to be a distinct and somewhat elementary error in Duchesne's calculation of the total heat, wherein he confuses between the total heat of water heating followed by evaporative expansion at saturation pressure and the total heat of condensation by sudden drop of pressure, and subsequent condensation to water at the low pressure. Between these two heating and cooling total heats there exists the difference between the two quantities $p\,v$ at the high and at the low pressures, even after assuming that all the kinetic energy is recovered as measured heat. If the sudden high-speed expansion curve were a true hyperbola this difference would be zero. But, although the isodynamics of perfect gases are supposed to coincide with their isothermals, and to be true hyperbolas, it is well established that the isodynamics of steam, especially those not far removed from the saturation curve, are not so.

On these various items of the account we are compelled to feel greater confidence in Herr Knoblauch's results, as shown on our diagram 1, than in those of Professor Duchesne, depicted in diagram 2.

It is, however, fair to add that Professor Duchesne's book contains accounts of extensive research upon the values of the quantity $p\,v$ of superheated steam obtained by taking pressure, temperature, and volume indicator diagrams from the compression strokes of his experimental engine, in which the conditions of compression can be varied through large ranges; and that, by theoretical calculations from these compression indicator diagrams, he believes that he finds confirmation of his more directly obtained experimental curves of specific heat.

THE LÖTSCHBERG-SIMPLON RAILWAY AND ITS CONSTRUCTION.

No. IV.*

THE Lötschberg tunnel line, as followed until the accident occurred, was planned for a length of 13,744 m. in a straight line between the Kander Valley and the Lötsch Valley, the orientation being North, 29 deg. West. As now built, it turns eastward from the straight line at kilom. point 1.203 by means of a curve of 1100 m. radius, 798 m. long, and then continues straight through sedimentary deposits until the granite of the Gastern is entered near the fourth kilometre. There the line, which runs beneath the lower spurs of the Fisistock and Doldenhorn, on the north side of the Gastern Valley, turns south under the glacier source of the Kander by means of a curve of 1100 m. radius, 1116 m. long. It then almost immediately passes below the mass of Gfell Alp, and subsequently the lower reaches of the lesser Hockenhorn. The line then continues straight until it regains the original straight-line trace of the tunnel just past the tenth kilometre, the angle of the two lines being turned through a short curve, 320 m. long, of 1100 m. radius, from which point the remaining 4.3 kilom. are straight, except for a very brief curve only 30 m. long and of 400 m. radius at the Goppenstein portal. The object of the latter curve appears to have been to direct the smoke during the construction away from the short alignment gallery, and so to facilitate back-sighting through the latter. The aggregate length of the curves is 2265 m., and of the straight line 12,271 m., in all a total of 14,536 m.

The new course of the line avoids passage below the glacier torrents flowing to the Kander from the Balmhorn, and also the Lötschberg glacier, which occurs right

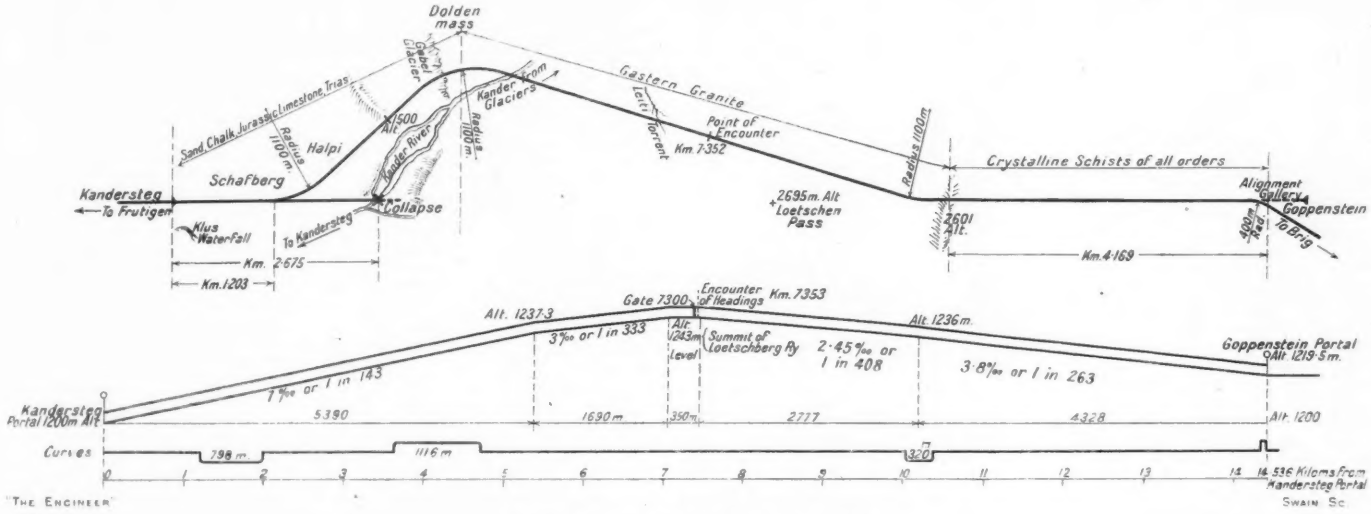


Fig. 7—PLAN AND PROFILE OF THE TUNNEL

above the former trace, while the passage of the higher Gastern Valley is now made at a greater depth below the surface than it was to have been lower down. The new route would therefore appear to be in some respects preferable to that originally projected, and had it been followed in a straight line from Goppenstein, it would have placed the northern entrance of the tunnel just above Kandersteg village at the level of the entrance to the Oeschinen gorge—see Fig. 4, page 580. It must be remembered, however, that the tunnel, as made, suffers the disadvantage of containing curves.

In anticipation, afterwards realised, of greater water inflows, and also by reason of the lower level at Kandersteg, the northern half of the line was built on the steepest gradient—that is to say, 7 per 1000, or 1 in 143, which in a length of 5390 m. gives $7 \times 5.390 = 37.7$ m. rise, or an elevation at this point of 1237.3, with the altitude at Kandersteg portal of 1200 m.

On the next length of 1690 m. extending up to the tunnel summit the gradient is reduced to 3 per 1000, giving a rise of $3 \times 1.690 = 5.07$ m., the total altitude attained at this point being therefore 1242 8 m. This is the culminating point of the new Lötschberg-Simplon Railway. The line continues level for 350 m., and then follows a drop of 2.45 per 1000 for a distance of 2777 m., which reduces the altitude to 1236 m., while the remaining distance of 4328 m., being on an increased gradient of 3.8 per 1000, the Goppenstein portal is reached at an altitude of 1219.5 m., or 19.5 m. above the level of the entrance at Kandersteg. See profile of line Fig. 7.

Work was begun by hand labour on the altered course of the line at kilom. point 1.203 on February 17th, 1909, after seven months of stoppage and extreme anxiety to the contractors since the night of July 23rd-24th, when, at a point some 100 m. before and to the north side of the Kander River, some 180 m. above in the Gastern Valley, the heading collapsed and the tunnel became choked up for about a distance of 1 4 kilom. with calcareous rock, detritus, sandy mud, &c., burying therein twenty-six

* No. III. appeared December 8th.

miners, only one escaping. To save the rest of the works, and the masonry section farther back, the first step taken was to seal up the tunnel with a wall 10 m. thick, in which were inserted seven drain pipes, three of 169 mm. bore at about 1 m. from the floor, and four more at about 2 m., the three lower pipes delivering a continuous volume of 6600 litres per minute, or 2400 litres more than the inflows at this point before the collapse. This wall was built, after clearing the inundated tunnel as far forward as possible, at kilom. point 1.430, or 1245 m. in rear of the point at kilom. 2.675 where the main inburst occurred. A huge fissure of 6 m. to 7 m. in width was discovered during subsequent investigations at the place of the rupture, besides numerous lesser fissures extending over a length of about 200 m. at both sides of the river line above, but principally on the north side, which is nearest to the tunnel entrance. The collapse appears to have coincided with the firing of a mine in the heading face situated over 100 m. further ahead, just when the miners had retired, as usual, some 100 m. or more rearwards. A wind wave of compressed air having extinguished all the lamps, the miners, it is said, not seeing anything ran towards instead of away from the inburst, At that time all danger was deemed to have passed away, because the line of the Kander River had already been crossed.

The passage of the 400 m. or so below the plain in the Gastern Valley was considered to be the most delicate undertaking in the entire enterprise, and the whole original plan of the tunnel turned about the realisation of the best conditions for its safe accomplishment. An inspection of the Gastern Valley above the tunnel line is

Fig. 8—MAP SHOWING COUNTRY TRAVERSED

particularly interesting in relation to the causes of the accident. Its topographic features may be followed in the plan—Fig. 8. The bed of the valley is a nearly flat plateau between high mountain masses rising almost perpendicularly at the south side, but more sloping on the north side, where the stones, detached and falling down from the cliffs above, form in many places steep screes. The valley bottom is evidently of a shifting character, being made up of broken stone or shingle carried from the hills by avalanches and glacier torrents, and then swept along by the rippling, fast-flowing Kander River. A little above the line of the tunnel the shingle has been driven into wide deposits, which form numerous islets, to force its way past which the river has spread laterally in search of other channels of escape, and these numerous streams meet together again just above the trace of the line—see Fig. 8. This continued blocking up the river's course, just before it reaches the cascades in the great rocky canyon below, has very possibly caused the water to seek subterranean outlets, precisely such as may be noted in the face of the high cliffs right opposite on the south side of the valley where, several hundreds of feet below any visible connection with the many avalanche slides on the mountain, a roaring torrent pours out of the apparently solid face of a vertical wall of rock, falling thence so far below that it only reaches the lower spurs in the form of misty spray. Such fissures may possibly be more numerous still below the river bed, and give rise to pockets or underground lakes, which may burst when undermined with a tunnel boring. To determine the geological conditions practically, and to clear out the inundated working if possible, two shafts were sunk in the Gastern Valley above the line of the tunnel, one at kilom. point 2.870, and another at kilom. point 2.700, and consequently 200 m. and 25 m. respectively ahead of the spot where the tunnel caved in. Of the results of the soundings in the Gastern Valley the details will not be made known until after the decision of the Court of Arbitration which is dealing with the matter, but their import may, perhaps, be judged by the fact that, notwithstanding all the pressure brought upon the contractors by the Lötschberg Railway Company, and by the Bernese Cantonal Government to compel the contractors to clear out the tunnel and to continue it onwards in the same straight line at their own risk, the latter positively refused to do this.

Two methods of excavating through the subsoils of the Gastern Valley so as to continue the tunnel in its original direction were at first proposed, namely, (1) solidification of the upper strata by means of concrete, the advance being made by means of shields and armoured concrete headings; or (2) by the freezing process. The first was found to be impracticable on account of the great inroads of the water, and the second was adjudged prohibitive because of the cost, it being estimated to require upwards of thirty shafts sunk in the Gastern Valley, through which to conduct the operations, and an extensive plant of from 2500 to 3000 horse-power. The whole would have

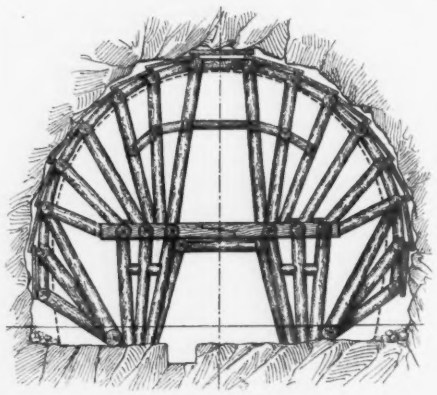


Fig. 9—COMPLETE TIMBERING

involved an extra cost of about 15 million francs, besides rendering it impossible to complete the railway within the prescribed time. Finally, after some months of delay, when the contractors were faced with the necessity of discharging their colony of workers at the north end, the two superior authorities, who were, for various reasons affecting traffic and working considerations, interested in maintaining the short straight line for the tunnel, accepted the contractors' project for an avoiding line, as already described. Although this latter was commenced on February 17th, as before remarked, and machine drilling was again started in the first curve of the line at kilom. 1.368 on February 22nd, 1909, the soundings by means of the two shafts in the Gastern Valley were continued for some three months longer for the purpose of securing various necessary data. It may be remarked that the Gastern Valley about this part is an attractive plateau, with fine level paths and prettily wooded copses, glens, and islands, but remarkable for its extraordinary silence, broken only by the muffled detonations in the mountains directly above. In the higher and wilder part of the valley below Brandhubel the deviated course of the tunnel now crosses 242 m. beneath the glacier torrent or main source of the Kander, and with some 200 m. of granite strata between it and the railway below. The Kander glacier is derived from the great snowfield

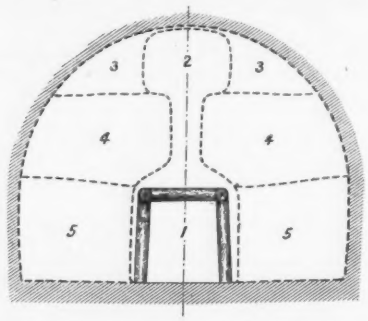


Fig. 10—EXCAVATION IN CROWN DRIFT

Kanderfirn, which on the other side of the ridge of Petersgrat furnishes all the glacier sources of the Lonza torrent in the Lötschenthal.

Returning to our description of the tunnel we may say that nothing is to be seen at the bifurcation of the old tunnel line, it having been sealed up with masonry for about 50 m. inwards, and references to the subject are made with some compunction by the engineers. Proceeding, a good deal of drip is noticeable at various points. The ventilating gallery or "gaine" is broken through or dismantled at various places. It is very simply constructed with channels of I section supporting a wall of red tiles, and at the time of our visit it ceased at kilom. 3.550. The various other contemporaneous positions of the different sections are here noted as an example of the general system of advance. The fully completed revetment reached to kilom. 5.600, and the station for compressed air locomotives was situated a little in arrear, at kilom. 5.500, it being moved forward at intervals so as to follow up the masonry section.

Between kilom. 5.700 and 5.800 the excavation to full profile is complete, and the revetment follows the advance, beginning with the walls and finishing with the crown at the key course. The full timbering, just previous to the commencement of the walls, is shown in Fig. 9. In due order, as these timbers are struck the arch centres are erected on wall stagings with the usual alignment wedges. The spacing of these centres and their strength vary according to the nature of the rock and also the formation of the strata. In general, the timbering of the original heading—visible in Fig. 9—is completely lagged above to prevent falls of rock on to the line below, and the lagging is retained farther back into a part of the masonry section. Through apertures in the boards at several points the voussoirs and building materials are hauled up by means of compressed air winches. In one or two places the lagging boards have been broken by falls of rock, and occasionally a large splinter of rock projects downwards through the lagging to the level of the heads of the men who ride in the empty spoil cars, but is avoided by a timely dodging, for the train speed is not great.

The systems of excavation are shown in the Figs. 10 and 11 as re-drawn from sketches made for us in mid-tunnel by the chief engineer of the excavation on the Goppenstein side.

In the method shown in Fig. 10, the advance is through crown drifts 2, or *en calotte*, driven from the base heading 1, and is effected by means of vertical shafts, these being opened at intervals of varying length, according to the nature of the soil—a system which was employed in the Simplon during the earlier part of the work. The sections 3, 4, and 5 are cut out by working downwards. In Fig. 11 is shown the method employed for less solid rock. In this the work is gradually carried up straight to the roof through 2, 3, 4, followed at once by

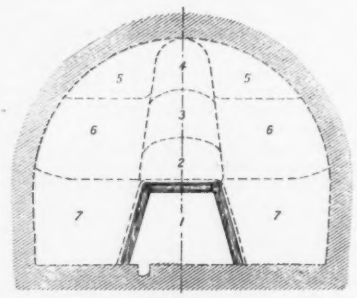


Fig. 11—DIRECT EXCAVATION

the erection of the central portion of the main timbering—Fig. 9—and then working down through 5, 6, and 7.

When the bottom level of the section 6 is reached, a strong transverse beam for the support of the radial roof posts has to be provided, and as this beam is of such length—about 7 m.—that it could not be turned transversely and erected in so narrow a space, it has to be made in two parts and then pulled together by means of a wooden drift key. Ordinarily the action of a wedge is to separate bodies. In this case the spliced ends of the timbers are cut with a shoulder forming on each a hook end; and a wedge driven between these hooks, as shown in Fig. 12, pulls the two halves together. These timbers are sawn from fir trunks of about 50 cm. or 55 cm. diameter into baulks of about 35 cm. by 40 cm., and after erection *in situ* in two halves they are bolted together by means of four 3 cm. bolts passing through upper and lower iron straps of about 12 cm. wide by 2 cm. thick. After they have been pulled down and re-erected from two to four times they become useless for further work.

Proceeding on from the full excavation section at kilom. 5.800, a fresh "attack" or excavation section is being started ahead at kilom. 6.200, and at kilom. 6.600 the railway line ends, as the gate which bars the thoroughfare of the tunnel is but a little beyond at kilom. 7.300. Beyond the gate, about 53 m.—at kilom. 7 353—was the point where the two advance headings met at 3.50 a.m.,

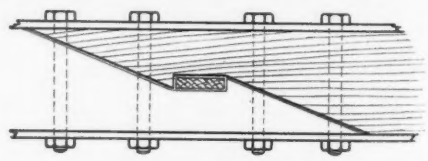


Fig. 12—JOINTED TRAVERSING BEAM

March 31st, 1911, with a difference in their centre lines of 102 mm. vertical, 257 mm. lateral, and with an error in length of 410 mm. less than the estimated length in a total distance realised of 14,535.49 m. The excavation section of the north side is in charge of Chief Engineer Pradda, to whose ready assistance many of these particulars are due.

The outstanding feature in the accomplishment of the work of boring the Lötschberg Tunnel is mainly the great progress effected in the capacity for rapid work of the modern rock drill, the other operations remaining much the same as before. In this enterprise two systems of compressed-air drilling machine and plant have made an important *début* in the history of great Alpine tunnels, that is, the Meyer and the Ingersoll-Sergeant. We do not recall their previous employment in other great European tunnels, although the Ingersoll machine was tested experimentally for a short time at the south end of the Simplon. The water-cooled compressed-air rock drilling machine, with percussive action, first came into notice with the Sommeiller machine in the Mount Cenis or Fréjus Tunnel, and was first worked, four mounted on one thrust column, on January 12th, 1861. Some of the same machines were afterwards used in the St. Gothard Tunnel, together with the Dubois and François (Belgian) machine on the Sommeiller principle, with the Mackean and the Seguin, and also with the Turretini and Colladon

drills, while in the Arlberg the Ferroux apparatus was employed at one end, and in many important Italian tunnels the Ferroux, the Blanchod, and the Segala have been employed, the Segala notably on the south approach line to the Simplon. Incidentally it may be added that the Brandt hydraulic rock-boring machine was used in the Simplon, in the Albula, on one side of the Arlberg, in the Sonnstein, and in the Pfaffensprung tunnels. It suffices to compare the rate of advance made with compressed-air drilling machines in the Lötschberg with the corresponding rate in some of the earlier tunnels named, to appreciate the great progress effected with compressed-air rock drilling plant in late years.

Taking the average speed of boring a hole 1 m. deep during three complete years of work in the Lötschberg Tunnel, we find 16 min. for the north end and 23 min. for the south end. In parenthesis, it should be at once remarked that this difference of 31 per cent. in the speed at either end of the Lötschberg Tunnel does not necessarily imply a superiority for one of the systems, because certain differing factors were involved, notably the lower air pressure in the drills at the Goppenstein end. The mean speed for the whole Lötschberg Tunnel in the period named is about 19 min. per metre of hole drilled. Now, taking at hazard any previous example, say, the Gotthard, with its many systems of compressed air drills, the time to drill 1 m. averaged 49 min. at Goeschenen, and 66 min. at Airolo, or a mean of 58 min. collectively. The greatest speed attained in June-July, 1877, and October, 1879, averaged 21 min. at Goeschenen and 31 mins. at Airolo. In the Lötschberg the highest speed during the third quarter of 1909 at the Kandersteg end was 12 min. per metre depth of hole drilled, while at the Goppenstein end in the second quarter of 1910 it was 16 min. per metre of hole drilled. Even allowing that the compact or schistic gneiss of the Gotthard involved harder work than the granite of the Gastern, and that the immense difference of the sanitary conditions upon the vitality of the men at the drills in the Gotthard all tended to lower the rate of progress, it is still apparent that the modern rock drill has been the principal agent in the higher rapidity of drilling in the Lötschberg.

Leaving the drilling momentarily, it may be remarked that the other operations in the advance heading, while they kept up with the faster work of the drills, appear to show no real acceleration in themselves, because they are dependent upon hand labour alone, and, given fair ventilation and good health in the men, they are not susceptible of great speed advance in a narrow space where too many hands would retard progress. In the Simplon, and latterly in the Lötschberg, the speeding up of the work of clearing the spoil from the heading face had been proposed by substituting machines for men, to economise time during that period of the operations comprising the removal of the drills, the firing of mines, the clearing of spoil, and the resetting of the drills at the face, variously termed, in the languages employed in the tunnel, *marinage*, *marinaggio*, *shuttzeit*. At the Simplon a large suction machine, on wheels, presumed to have the power to lift the *débris* from exploded mines, was tested and at once abandoned. In the Lötschberg a sort of dredging grab, mounted on trucks, and with a total sweep of the two halves of about 1.8 m., was introduced. The machine was intended to be driven forward into the heading by a small compressed air locomotive, to lift the spoil at one scoop of the jaws, and then to run back to a siding, where the material could be dropped. Such a proceeding was considered so dangerous by the chief engineer of mechanical plant at Kandersteg that, without admitting it into the tunnel, he had timbers erected at the works to the dimensions of the tunnel heading—about 2.5 m. wide and 2.10 m. high—and rigged up with all the pipes and accessories that have to find place at the sides of an advance heading, and then invited all those who cared to take the place of miners and the others who usually work in the advance heading, while the machine was driven in and operated. Not the least dangerous possibilities of mechanical clearance—it cannot be called excavation—in the tunnel was the chance of striking unexploded cartridges, which, in spite of the usual counting, will turn up in the spoil at times, as has already been proved by some unpleasant experiences. The mechanical shovel was thereupon left abandoned in the yard at Kandersteg, where it has since stood as a further example of the failure until now to contrive an apparatus which could greatly accelerate an operation where there is still urgent need of higher speed.

CRYSTAL PALACE ENGINEERING SCHOOL.—The "Wilson Premium," for the best paper read before the Crystal Palace Engineering Society (affiliated to the Society of Engineers, Incorporated), during the present session, has been awarded by the Council to M. F. Da S. Cravo, for his paper on "Aviation." Other papers read during the session were:—"Railroad Construction," by W. R. L. Beaumont; "Cement Testing," by A. Zammar; and "Bridge Construction," by M. M. Beg. The Premium was presented to Mr. Cravo by Sir Douglas Fox, Past President of the Institution of Civil Engineers, on the occasion of the 117th Distribution of Certificates of the above School on Tuesday, December 19th.

OBITUARY.

SIR JAMES CHARLES INGLIS.

IT is with very great regret that we have to record the death, near Brighton, on Tuesday night of this week, of Sir J. C. Inglis, general manager and consulting engineer to the Great Western Railway Company. By his death the railway company in particular, and the engineering profession in general, have sustained a very severe loss, for Sir James was a man of sound knowledge and sterling merit. Like so many engineers holding high positions, he was a Scotsman, having been born at Aberdeen in 1851. After receiving his first instruction at the Grammar School of this city, he proceeded to its University, but he was not destined to complete his course there, as, acting on the strongly expressed advice of Mr. James Abernethy, he decided to forego the taking of his degree, and instead to proceed at once to the study of practical engineering. When nineteen years old he accordingly entered the shops of Norman Copeland and Co., millwrights, of Glasgow, where he remained for two years. Mr. Abernethy had evidently not given the advice he did without meaning to help the young man to the fullest extent in his power. Indeed, the interest the former took in the latter was most marked, and as a first earnest of this he received young Inglis into his office as pupil when his time in the Glasgow shops was over. Mr. Abernethy's business consisted largely in the design and construction of harbours and docks, and it was on work of this nature that Inglis was first engaged. Between the years 1872 and 1875 he assisted in the carrying out of the Alexandra Dock and railways, being afterwards employed in the construction of the Great Western Dock at Millbay, Plymouth, under Mr. P. J. Margary, the chief engineer of the South Devon and Cornwall Railways. In this position he was responsible, as engineer to the Cattewater Harbour Commissioners, for the building of the Mount Batten breakwater. His work at this and in other places attracted considerable attention, and when the Great Western Railway absorbed the South Devon line he was offered a position on the staff of the former. This he accepted in 1878, much, it is said, to the disappointment of Mr. Abernethy, who not only evidently wanted to retain such a promising engineer on his own staff, but who thought, or at any rate feigned to think, that the building of a railway called for no more skill than the making of a road.

That young Inglis made a wise choice there can, however, be no two opinions. Exactly how long he remained in the service of the Great Western Railway after first joining it we are unable to say, but it was not very long, for he decided to commence business on his own account as a consulting engineer. In 1881 he was engaged upon the Princetown Railway, and subsequently constructed Newlyn Harbour, near Penzance, in 1883, the branch line to Bodmin in 1884, afterwards being concerned with the Boscarne extension, the rebuilding of the viaducts on the South Devon line at Cornwood and Ivybridge, and with the Marley Tunnel. In 1890 he commenced the Torquay Harbour Works, of which Mr. Abernethy was consulting engineer, and it was during the progress of this under-taking that Mr. Inglis received his second invitation to join the staff of the Great Western Railway. In 1892 he was offered the post of assistant engineer at Paddington and he accepted it, and thus entered upon a connection with the line which was to continue without a break right up to the day of his death.

It would be well-nigh impossible to say exactly how much the Great Western Railway owes to the genius, business ability and tact of the man whose services were thus secured for a second time. The line has, during the past twenty years, been going through a period of wonderful development. Slowly and surely it has been bettering its position. Round-about routes have been superseded by direct lines, a harbour of fine proportions has been built at Fishguard, and a service of steamships started between that port and Rosslare, in Ireland; the longest non-stop run in the world has been instituted, and altogether the status of the line, which was always high, has been considerably improved. Inglis, the engineer, ably backed by Mr. Dean, and afterwards by Mr. Churchward, was responsible for the technical work involved, but how much was due to Inglis, the man? It would be hard to say; but we venture to think that the real answer would be "a very great deal." At any rate, the estimation in which he was held at such an early period of his life as the age of forty-one by the directors of the line is shown by the fact that four months after coming to London he was made chief engineer.

It would be impossible, in the short space at our disposal, to enumerate all the great improvements which were carried out during the period that Sir James held office. We may, however, mention, in addition to the Fishguard undertaking, the new short route to Birmingham, the completion of the North Warwickshire and Cheltenham and Honeybourne lines, which brought Birmingham and Bristol into direct communication, the direct route, *viâ* Westbury to Exeter, the doubling of the line in many places in Cornwall, and the replacing of the old wooden trestle bridges on that portion of the line with masonry structures. In the whole of these works there has been one central idea, namely, the strengthening of the position of this fine line to the West, and in this the efforts put forward have been eminently successful. No opportunity has been lost to examine new inventions and to test their worth. Part of the line near the metropolis has been electrified; mechanical fog signalling and signalling have been installed, every new design in locomotive construction has been given a trial, and, in a word, the Great Western Railway may certainly be regarded as one of our most progressive lines.

After being chief engineer for eleven years, Sir James was, on the sudden death of Sir Joseph Wilkinson, made general manager and consulting engineer of the line, and the policy of appointing to this post a man of high engineering attainments—a course also adopted by the Lancashire and Yorkshire Railway—has been amply justified. While still retaining the advantage of Sir James's professional experience, the railway has profited by the employment in a wider sphere of action of his undoubted administrative and constructive abilities. The progress made has been continuous and uninterrupted, and his loss will, we are convinced, be most keenly felt.

While devoting himself wholeheartedly to the work of his company, Sir James, who, we may state here, received the honour of knighthood early in the present year, yet found time to turn his attention in other directions. He was a regular attendant at the meetings of the Institution of Civil Engineers, and during the years 1908 and 1909 was president of that body. He was arbitrator for the purchase of the Tanjong Pagar Docks; he served on the Royal Commission on Canals and Waterways, and was an active member of the Engineering Standards Committee.

He was a man of charming personality. Among the last of his public actions in connection with the Institution was the laying, on October 25th, 1910, of the foundation stone of the New Buildings. It was during his term of office that practically all of the work in connection with this building was carried out. No doubt it was on this account that it was he who was called upon to lay the stone, which ceremony, as his term of office as President had terminated, would in the ordinary course of events have been performed by the then President, Mr. Alexander Siemens.

This was always in evidence when he was presiding over a meeting of the Institution, and the fact that he was for two years running the President is eloquent testimony to the esteem in which he was held by his fellow members of Council, and by the whole of the members.

SIR JAMES INGLIS

EXHIBITION OF AUTOCARS AND AERIAL NAVIGATION, PARIS, 1912.—A commission has been appointed by the French Government for the purpose of organising an exhibition of motor cars and aërial navigation in Paris next year. The exhibition, which has the support of some of the most important firms in the trade will probably be held in the Grand-Palais.

THE MALLET LOCOMOTIVE ON AMERICAN RAILWAYS.

No. II.*

THESE large engines are necessarily of great length, and advantage has been taken of the opportunity offered to equip them with auxiliary steam economising or fuel economising apparatus, so as to make them more efficient as steam generating machines. The additional length permits of practically doubling the length of boiler barrel, and the steam bogie, of course, must carry sufficient weight for the desired adhesion. But a tubular boiler 30ft. to 40ft. in length would be a very doubtful advantage, for, as a matter of fact, an increase in length of tubes much beyond 20ft. gives little increase in steaming or evaporative power. Furthermore, such an arrangement is not necessary to attain the requisite steaming capacity, and for converted engines it would mean the additional expense of a new boiler. Instead, the endeavour is made to utilise a greater proportion of the heat.

which was illustrated in THE ENGINEER for September 24th, 1909; it is composed of a series of steel channels bent to horseshoe shape and riveted together through the flanges. No stay bolts are used, but transverse stay-plates or diaphragms of horseshoe shape are riveted between the flanges of the channels, the webs of the plates being cut away sufficiently to permit of the free circulation of water. Beyond this is the boiler barrel proper or the evaporating portion, and the tubes deliver into a combustion chamber which would be the smoke-box of an ordinary boiler. Beyond this, again, is a tubular portion divided into two parts by an intermediate tube plate. The rear part is the superheater for live steam, while the forward part is the reheater for the high-pressure exhaust on its way to the low-pressure cylinders. This is the Buck-Jacobs device, which has already been described in THE ENGINEER—March 11th, 1910—and is shown in section in Fig. 8. After passing through these tubes the products of combustion enter a second and shorter combustion chamber, beyond which is a long tubular section forming the feed-water heater. Finally, at the forward end, and a spherical joint connection with the smoke-box, this latter joint being also a vertical swivel joint.

For the high-pressure cylinders the steam distribution is controlled by piston valves 13in. diameter, of the inside admission type. By-pass valves are placed above the valve chests, and are flat valves seated over upward extensions of the live steam ports. When the regulator is open these valves are held upon their seats by steam pressure, but if excessive pressure occurs in the ports, it will lift a valve and open communication between the two ends of the cylinder. The low-pressure cylinder arrangement is very similar, and it also has the relief valves; its piston valves, however, are 15in. diameter and of the outside admission type. The transverse distance between centres is 7ft. 4in. for the cylinders and 8ft. 4in. for the valve chests. The Walschaerts valve motion is used throughout, and all the valves are set with a constant lead of ¼in. A compressed-air reversing gear is used, and the reach rod connecting the high and low-pressure valve motions is placed in the centre line of the

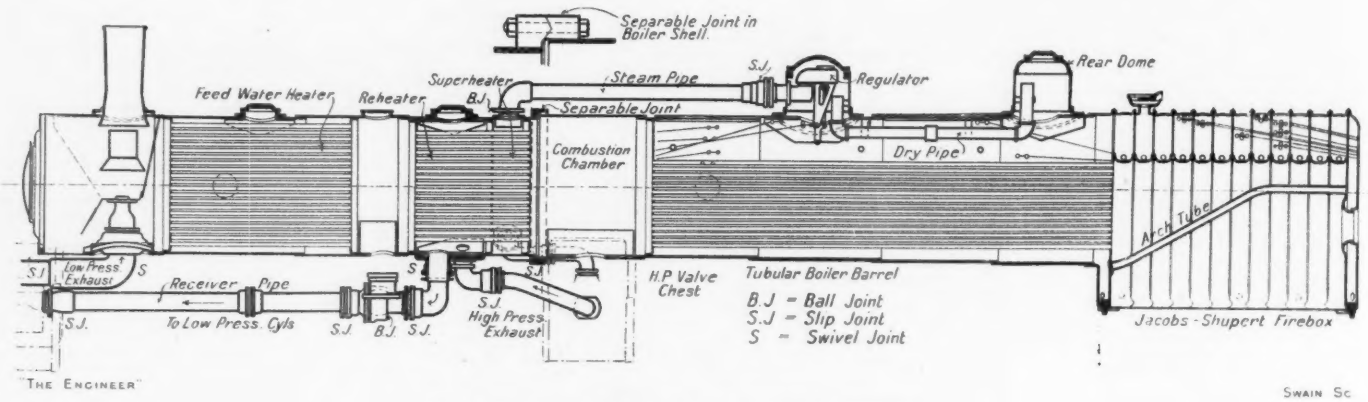


Fig. 6—TYPICAL BOILER FOR LARGE MALLET LOCOMOTIVE

The boiler extension in many cases contains one or more of the following three elements:—First, a feed-water heater; secondly, a steam superheater; and, thirdly, a reheater for the high-pressure exhaust. The feed-water heater is usually a tubular section duplicating the boiler barrel but having a length of 5ft. to 10ft. The injectors deliver the feed to this, and the outlet leads to the boiler check valves. The superheater and reheater are of different kinds, as required by different railways, or applied by different builders. The economy which may be realised in this way, and the extent to which the heat is thus absorbed from the products of combustion, are indicated by a series of tests made by the Southern Pacific Railway on a division 87 miles long having gradients of 1 in 45. The Mallet engine was of the 2-8-8-2 type, with cylinders 26in. by 30in. and 40in. by 30in., 6393 square feet of heating surface, 1220 square feet of feed-water heater surface, and 655 square feet of reheater surface—in a Baldwin smoke-box apparatus. There was no superheater. The engine weighed 190 gross tons, and 176 tons on the drivers. The other engine was a simple locomotive of the 2-8-0 type, with cylinders

there is the smoke-box, with a wire-netting partition and a draught pipe or petticoat pipe beneath the funnel.

The superheater and reheater are fitted with baffle plates, which compel the steam to follow a circuitous route in passing from the inlet to the outlet. Two non-lifting injectors deliver the feed-water to the heater, which is kept constantly filled. When the injectors are working the hot-water overflow from the heater passes out by two openings in the manhole cover, and enters the boiler proper through check valves set a short distance back from the front tube plate. A safety valve is mounted on the heater, and provision is made for washing it out.

Steam is taken from a point immediately in front of the fire-box by means of a dome, in which are enclosed the ends of two dry pipes 5in. diameter, the other ends entering the main dome in which the regulator is placed. A horizontal plate in this latter dome shuts it off from direct communication with the boiler. The regulator takes steam only at the top. The steam pipe passes out through the front of the dome, and extends over the top of the boiler, having a slip joint to allow for expansion

engine. This is a very simple arrangement, and a single universal joint, situated directly above the articulated connection or hinge pin of the steam bogie, provides against any distortion of the movement of the valves when the bogie swings on the curves.

The radius bar of the steam bogie is a heavy steel casting, approximately triangular in plan, with double webs by which the legs are bolted to the top and bars of the side frames. The stem fits between the bottom of the cylinder saddle casting and the top of a cross brace between the main frames. The hinge pin, which is inserted from below, passes through the brace and radius bar and into a socket in the saddle. The arrangement permits the frames to oscillate vertically without binding or gripping the joint. The two rails or bars of the fixed main frames have projections which extend between the bars of the bogie side frames, all four bars being in the same vertical plane. Any transfer of load between the frames at this point is made, therefore, by actual contact between the frames. A starting valve provides for admitting live steam through a 1½in. pipe to the low-pressure cylinders, thus giving a tractive force equal to the limit of adhesion.

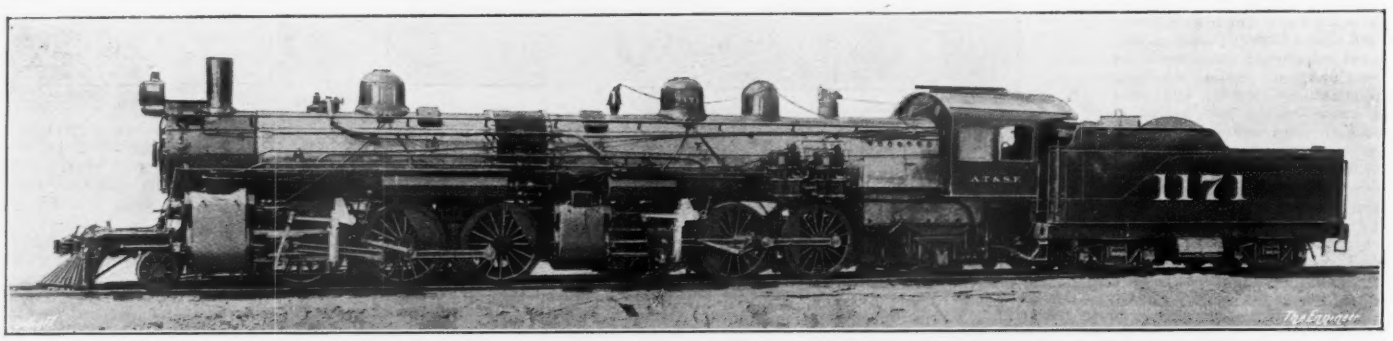


Fig. 7—MALLET 2-6-6-2 GOODS LOCOMOTIVE WITH FLEXIBLE JOINT IN BOILER

22in. by 30in., 57in. driving wheels, 93 tons total weight, and 83 tons on the drivers.

The Mallet locomotive developed 2486 indicated horse-power at a speed of 18 miles an hour, and showed a boiler efficiency of 78.52 per cent., as compared with 72.88 per cent. for the simple engine. The average temperature of the smoke-box gases was 451 deg. in the Mallet and 738 deg. Fah. in the other engine. The Mallet locomotive showed an advantage over the other of 7.81 per cent. in equivalent evaporation per pound of fuel, 14.04 per cent. in ton-miles per gallon of water used in the cylinders, 22.50 per cent. in ton-miles per gallon of oil burned, and 119.54 per cent. in train tonnage hauled.

A typical boiler for a high-power Mallet locomotive is shown in Fig. 6, representing one of a number of engines of the Atchison, Topeka, and Santa Fé Railway. A view of one of these is given in Fig. 7, and its dimensions will be found in the table accompanying the previous article. This boiler has a fire-box of the Jacob type,

* No. I. appeared December 8th.

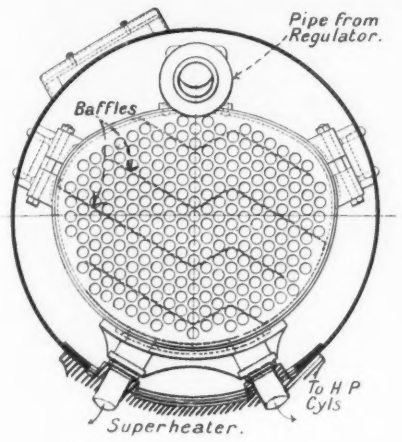
movements. An elbow with a ball or swivel joint conveys the steam through the boiler shell and into the superheater. The superheated steam passes out at each side by a pipe leading to the high-pressure steam chest, each pipe having a slip joint. The high-pressure exhaust on each side is led forward by a pipe which also has a slip joint, and which is attached to a steel casting on the bottom of the reheater. After passing through the reheater, the steam emerges again through a bottom connection to the receiver pipe, this connection being a vertical swivel joint. In the horizontal lead of the receiver there are slip joints, and a ball or spherical joint. These arrangements provide for all variations in the relative positions of the boiler and the frames. The receiver pipe terminates in a steel box casting, to which the low-pressure cylinders are bolted, and which is cored out for connections to pipes leading to the valve chests. The exhaust from each low-pressure cylinder is carried forward by a pipe which extends across in front of the cylinder, the two pipes connecting with a single flexible return pipe which terminates in the base of the blast pipe in the smoke-box. This return pipe has a slip joint

In view of the numerous sharp curves—573ft. radius on the main line and 380ft. on sidings—oiling devices are applied for lubricating the flanges of the front driving wheels of the steam bogie.

The engines described are representative of modern development in large Mallet locomotives. A number of them are in use on the Atchison, Topeka and Santa Fé Railway, all built by the Baldwin Locomotive Works. Very similar engines are in use on several other railways of importance. In regular service on the Atchison Railway, a 2-8-8-2 Mallet engine has a record of 3,887,300 gross ton-miles for four months, with an average fuel consumption of 405 lb. per 1000 ton-miles. A powerful simple engine of the 2-8-0 type in the same service made 1,597,200 ton-miles, with a fuel consumption of 581 lb. per 1000 ton-miles, or a saving of 176 lb.—30.3 per cent. —for the Mallet engine. The boiler efficiency for the Mallet was 81.4 per cent., and the temperature of its smoke-box gases was 405 deg. Fah. On the 2-8-0 simple engine, with Baldwin superheater in the smoke-box, the temperature of the escaping gases was 576 deg. and the boiler efficiency was 70 per cent. In a tandem-

compound 2-10-2 engine without superheater the temperature was 584 deg. and the boiler efficiency was 74.6 per cent. All these figures are averages of several trips.

The arrangement of auxiliary apparatus—such as superheaters and feed-water heaters—in the boiler extension of these long Mallet engines has been referred to already. One advantage of this is simplicity not only in construction, but also in repair work. The boiler proper—on the fixed frames—and its extension—supported on the steam bogie—are put together with an outside ring joint. A heavy cast steel ring or flange is



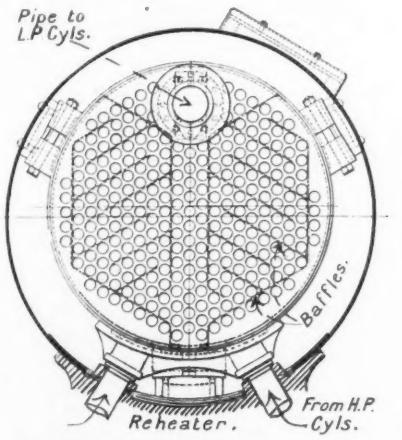


Fig. 8—COMBINED SUPERHEATER AND REHEATER

riveted to each of the adjacent ends, the face of one ring having a groove of triangular section, while that of the other ring has a corresponding projection. These rings are bolted together with horizontal bolts, making a separable joint. For renewing tubes or other repair work the joint is unbolted, pipe connections are taken down, and the two parts of the engine can then be separated entirely.

The boiler being rigid its front end must, of course, be supported on the steam bogie in such a way as to allow free action of the latter in curving. There are certain disadvantages in this arrangement, and these have led to

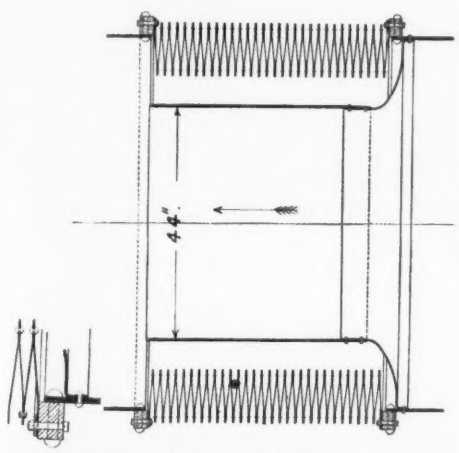


Fig. 9—ACCORDION FLEXIBLE BOILER JOINT

some very interesting developments in the design of a flexible boiler; that is, the use of a flexible joint for connecting the two sections. With such a joint the rear portion is attached rigidly to the main frames in the usual way, and the forward portion is similarly supported on the frames of the steam bogie. This eliminates the sliding saddle supports of the boiler, with the objectionable features attendant upon their use; at the same time it simplifies the steam piping, as no flexible joints are required in the low-pressure exhaust pipe. The curve resistance is materially reduced, and on curves there is no impairment of the stability of the engine due to the inertia and lateral displacement of the boiler upon the bogie. On sharp curves, also, there is less liability of interference with the clearance limits of structures or of trains on a parallel track.

Two of the Mallet 2–6–6–2 goods engines, built by the Baldwin Locomotive Works for the Atchison, Topeka, and Santa Fé Railway, have flexible boilers built on this principle. The joints, however, are of two distinct types; one is of the bellows or accordion type—Fig. 9—while the other is a development of the ball or hemispherical joint used in making flexible piping on the engines, as shown in Fig. 10. The end of each adjacent section of the boiler is formed as an open chamber; the superheater is placed in the chamber of the rear portion, while the reheater is placed in that of the forward portion. This arrangement is shown in Fig. 10.

The engine shown in Fig. 7 has the accordion joint. This—shown in detail in Fig. 9—is composed of sixty rings of high-carbon steel. The rings are 6ft. 3¼in. diameter on the outside, 10in. wide, with a thickness of No. 14 W.G. They are given a slight set or dish, so that when assembled they form a series of V shaped joints. The adjacent rings are riveted together at the inside contacts, and bolted together at the outside contacts. The end rings are bolted to steel flanges on the edges of the rear and forward sections of the boiler shell. To prevent cinders from lodging in the recesses, a cylindrical flue 44in. diameter extends through the joint; the rear end of this flares out and is riveted to the boiler shell, while the forward end is supported by a diaphragm.

In the hemispherical flexible joint shown in Fig. 10 there are two cast steel sleeves, 1 and 2, telescoped together, with the outer end of each formed as a segment of a sphere. A collar of corresponding shape, 3, is fitted inside each end of the boiler, being bolted to a flange

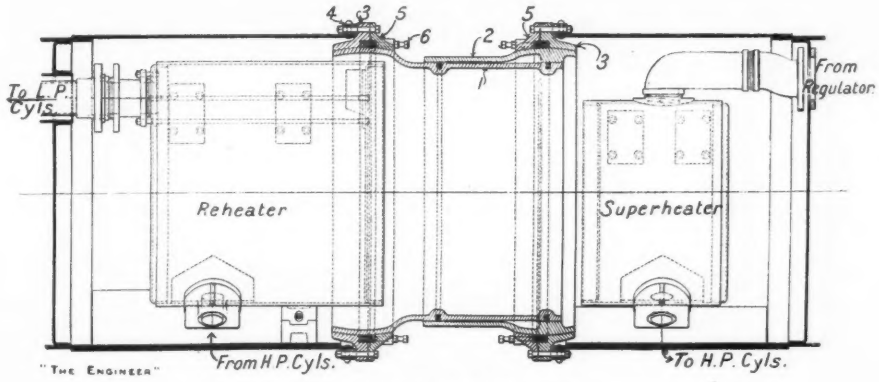


Fig. 10—FLEXIBLE BOILER JOINT

ring, 4. With the sleeves in position, outside rings, 5, are bolted up. A ring of soft metallic packing is fitted to a groove in the outer rings, and this can be tightened by turning a series of set screws, 6, which compress the packing and cause it to flow and make a close fit upon the surfaces.

The arrangement of the steam piping on these engines differs somewhat from that described above as applying to similar engines with rigid boilers. The pipe from the regulator runs to the superheater, from which the steam passes through passages in the cylinder saddle and through short elbow pipes to the valve chests of the high-pressure cylinders. The exhaust from each cylinder is led to a box casting on the steam bogie by a horizontal pipe outside the frames. These pipes have both slip joints and hemispherical joints to accommodate the movements of the bogie. The casting or cross brace supports the rear end of that part of the boiler which is carried rigidly upon the bogie, and passages in the casting communicate with the reheater. There is a single outlet pipe in the front end of the reheater—as shown in Fig. 10—and this pipe is led forward through a flue in the feed-water heater to the smoke-box, where an elbow pipe is connected to the passages in the steel box casting which forms the cross brace for the frames and the saddle for the low-pressure cylinders. These steam passages lead to the valve chests. The exhaust pipes leading to the smoke-box and blast pipe are rigid, as in ordinary engines, since the smoke-box has no motion relative to the bogie or cylinders.

One of the most notable developments in the use of Mallet locomotives in the United States is the decision of the Atchison, Topeka, and Santa Fé Railway to use this type exclusively for its through goods on the entire main line between Chicago and San Francisco, a distance of about 2200 miles. This includes prairie country and mountainous country, and while at present the trains are made up to meet these conditions, the new plan is to operate a standard train of 2200 tons over the whole line. For this purpose, of course, engines of different types will be used: 2–6–6–2 on the easier portions, 2–8–8–2 on the more difficult portions, and 2–10–10–2 on the divisions having the most severe conditions. This service will require about 300 engines, some of which will be entirely new, while others will be formed by adding a new front end unit to existing engines of the 2–6–0, the 2–6–2, the 2–8–0, and the 2–10–2 types. This conversion will cost from £2000 to £3000 for each engine. In addition to this there will be certain expenses for larger turntables—120ft. diameter—and for lengthening stalls in the engine-houses. It is estimated that this method of working will effect a saving of 30 per cent. in fuel and 14 per cent. in engine expenses, calculated on a ton-mile basis, besides a very large saving in wages of train men and engine men. The total initial expenditure will be about £900,000 for locomotives and £100,000 for turntables and alterations to engine-houses and running sheds, or £1,000,000 in all. The estimated saving in working expenses is £500,000, or an annual saving equal to half the initial outlay.

The dimensions of the enormous Mallet engine of the 2–10–10–2 type are as follows:—

Cylinders, high-pressure	28in. by 32in.
,, low-pressure	38in. by 32in.
Driving wheels	4ft. 6in.
Wheel base, rigid	19ft. 9in.
,, driving	50ft.
,, engine	66ft. 5in.
Total length over engine and tender	121ft. 6in.
Steam pressure	225 lb.
Length of fire-box	12ft. 6in.
,, boiler tubes	16ft. 6in.
,, combustion chamber	8ft.
,, superheater tubes	3ft.
,, reheater tubes	5ft.
,, feed-water heater tubes	9ft.
Heating surface, boiler	3920 square feet
,, superheater	580 square feet
,, reheater	1307 square feet
,, feed-water heater	2659 square feet
Oil fuel in tender	4000 gallons
Water in tender	12,000 gallons
Weight of engine, tons (English)	223 tons
,, on driving wheels	197 tons
,, of tender	100 tons
Tractive force	110,000 lb.

The increasing traffic, the great distances for through goods traffic, the increasing demands for economy, and the opportunities which are afforded for reducing working expenses by concentrating traffic in fewer and heavier trains, are all conditions favourable to the introduction of the Mallet locomotive and to its development on a scale of size and power which would not be possible except under the peculiar conditions of railway operation which exist in the United States. It is believed that investment in locomotives of this sort will be large, and that this is one of the few directions in which large reductions may be effected in working expenses.

THE SUCTION OF VESSELS.

(From a Correspondent.)

THE technical evidence which was forthcoming in the case of the collision between H.M.S. Hawke and the R.M.S. Olympic was largely directed to the little understood question of the relative reactions on one another of vessels under way. The subject is an extremely complicated one, and though the fact that these reactions may be very strong has for long been well known, exact data with regard to them is very scarce, and it might easily have remained an unexplored field for some time to come had not such prominence been given to it in this recent important instance. A definite investigation of the causes of this action and of their extent is not easy to make, because not only are the phenomena of an extremely unstable nature, but the matter is all the more involved on account of the influence that the depth of water exerts on wave formations. That ships are attracted to one another even when under way is well known to naval officers used to manœuvring fleets in close order, and especially is this the case when squadrons of torpedo craft are manœuvred in the inverted V-shaped formation so frequently affected by the German navy. With the view of trying to remove some of the obscurity which shrouded this question, about three years ago the United States Navy Department conducted a series of model trials in the Washington Experimental Tank, which are of considerable interest at the present moment in view of the elaborate trials recently made at Teddington with models of the Hawke and the Olympic. Four models in all were tried at Washington; they were 20ft. 6in. long and displaced 3000 lb., but the beam and draught were slightly varied. These models were towed in pairs abreast one another, and at definite distances ahead and astern. In the breast positions they were towed at various distances apart—see Fig. 1. Mr. D.W. Taylor, in his paper to the American Society of Naval Architects, read in 1909, on these trials, calls attention to the fact that these experiments were made in water many times the draught of the models, and hence the suction effects under given conditions would be less than if the water had been shallow, as is usually the case when suction phenomena are of importance in connection with actual ships. With the four models two series of trials were made. In the first, where each model had a prismatic coefficient of .56, the model with the finer midship section and block coefficient was towed in a series of positions on the starboard quarter, abeam, but with different distances apart, and on

the starboard bow of a rather finer-ended model, thereby representing in a way, except for depth of water, the Hawke passing the Olympic. The second pair of models had the same coefficients throughout—the prismatic value being .74—but the passing model was much wider in relation of beam to draught than is usually the case. The method adopted in running these trials was to measure the pull or repulsion of two points, one near the bow and the other near the stern of the overtaking model, which was towed at varying distances, all percentages such as .8, .6, .4 and so forth forward and abaft the beam of the other model. The magnitude of the pull in or push out was expressed as a fraction of the model resistance when towed in the ordinary manner. Some extraordinary information was gained from these trials, and curiously enough it has been almost exactly corroborated by the Teddington experiments of recent date. The results obtained from the fine models were rather more consistent than those obtained from the second pair, though the latter tend to corroborate the former.

It appears that if one vessel overtakes another at a short distance away on a parallel course, when the vessels just commence to overlap, there is repulsion observed at both bow and stern of the overtaking ship, the effect being greater at the stern, with the result that the tendency is for the overtaking vessel to turn in towards the vessel ahead. When the relative positions are such that the following ship's forward perpendicular is about 40 per cent. of the leading ship's length past her stern, the tendency is for the bow to be drawn in and the stern even more strongly repelled. As the overtaking vessel continues to come up, the suction at the bow increases, but the repulsion at the stern decreases; when the ships come abreast, however, there is a strongly marked change in the stern force which alters from repulsion to considerable suction, and, as the overtaking vessel passes, the conditions are entirely reversed from their original direction. The sternward pull-in becomes stronger and reaches a maximum when the centre of the overtaking vessel is about 20 per cent. ahead of the other's beam. Until more definite data can be determined this danger zone in relation to depth must remain an unknown quantity. We do not attach too much importance to the views of the captains of large ships, as regards such an abstruse problem in naval architecture, because their instructions are to avoid proximity to another vessel as far as possible, and they seldom possess the detailed technical knowledge of the subject of wave making and kindred phenomena to enable them to eliminate or to allow for the variable quantities present on such an occasion. As regards the influence on the Olympic, the passing of the Hawke would not affect her much more than passing the West Bramble buoy would, but the Olympic displaces as much as seven Hawkes, and is a truly immense mass to proceed at over 15 knots in shallow water, and her effect on another ship has probably only just been appreciated. Fig. 2 gives an idea of the relative sizes of the two vessels, and how little, when the size of the Olympic is considered, a distance of 100 yards apart appears.

Now from the Teddington experiments it was seen that when the cruiser was forward of the Olympic's beam, the model sheared out in shallow water and sheered in in deep water, an instance of variable and unstable performance that at first sight seems hard to account for. When her bow was overlapping one-fourth of the Olympic there was a very strong tendency to swerve in; after passing she was repelled. The question of danger space was not settled, but probably the effect would extend about 600ft. on the quarter and become almost irresistible at 250ft. to 300ft. with a ship of the Olympic type displacing 50,920 tons at 33ft. 9in. draught; that is to say, after a certain position had been reached it might be almost impossible to avoid a collision. It is also a curious fact that the operation of the rudder may not assist at all in clearing. It may even force the collision, although put over with the idea and direction of swinging clear. This is evident from a consideration of the relative amounts of "pull in" and "push out" at bow and stern respectively, when the following ship overlaps the after third of the first vessel. If, coming up on the starboard quarter—the effect, of course, is the same on the port side, only the directions are reversed—the helm is put over with the idea of swinging the bow out, the result will be either a diminution of the force at the stern which is pulling the stern to starboard, or its reversal, which will push the stern to port. If it is not reversed there will still be the tendency to swing the bow closer in. If it is more than balanced, both bow and stern forces would pull the model bodily to port and probably bring the vessels together regardless of rudder action. In any case, steering in shallow water is never any too certain. A "Suez Canal rudder" is a well-known fitting, and a ship steaming fast with deep water on one beam and a rapidly shelving bank on the other is none too easy to keep on straight course.

In the Washington experiments the models were compelled to remain parallel to one another. An interesting feature of the results was the attraction for one another even when as much as a third of a length apart when towed abreast. Under the circumstances, the first two models when towed at distances apart corresponding to .19, .24, and .28 of their lengths exhibited practically double the attractive tendency at the stern to what it was at the bow; the attraction in the case of .24 lengths apart was half what it was at .19 and half at .28 of that at .24, showing a rapid reduction of effect as the distance increased. This paper of Mr. D. W. Taylor's is worthy of careful study in this connection; it is perhaps one of the many that are presented to the engineering societies that lie buried in semi-oblivion, except to the specialists, until some casual incident entails a search for wider knowledge of a subject. These experiments, as also those at Teddington, have only commenced to tackle the fringe of an important subject. In practice the rule of the road should be interpreted in a liberal spirit, and from some who have had practical experience of this suction effect, these experiments were criticised on the ground that it is not only the overtaking vessel that has cause for anxiety, because the overtaken ship is caused to sheer also. Some extraordinary cases of this action have been recorded on the Great Lakes, and the theory of suction, now known to be a potent factor especially in shallow water, was at first received with much reluctance by the nautical assessors who were appointed in cases of collision. In the discussion that followed the reading of Mr Taylor's paper, various instances were adduced regarding the observed effect of suction on passing vessels, which tended to corroborate the experiments, in spite of the fact that the conditions were not absolutely analogous. The models were not fitted with rudders, and they were compelled to remain parallel at a given distance apart; it was only the sidewise pull or push on the bow and stern that was measured, and not the actual amount of deflection.

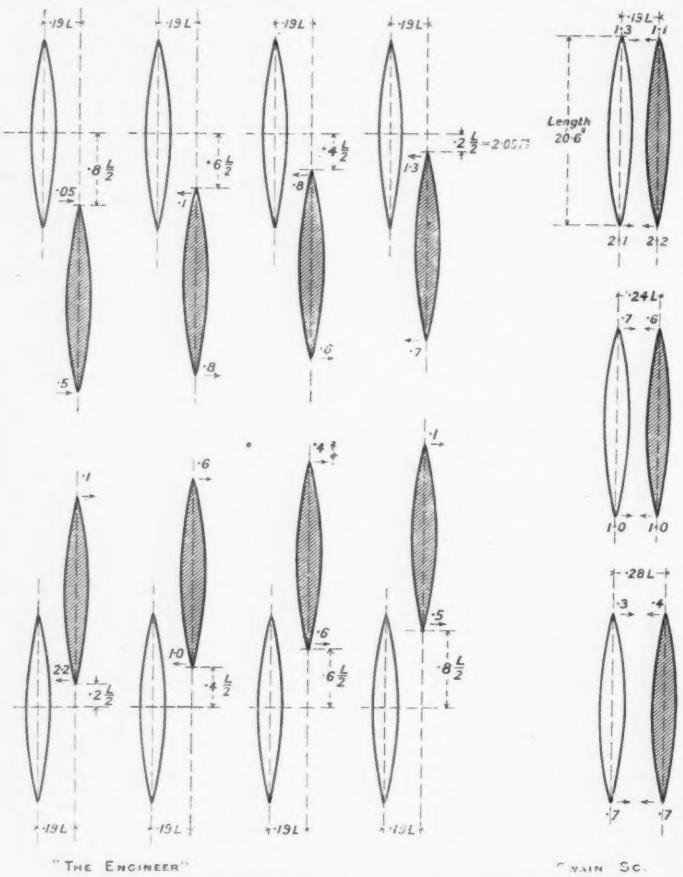


Fig. 1—INTERACTION OF PASSING VESSELS

The reasons for this suction effect can be deduced from stream-line considerations and our existing knowledge of the flow of water past a ship's hull. In the neighbourhood of the fore body there is a field where the pressure of the water is increased over what it would be if the ship were not present; the water itself is moving outward and forward. Passing aft, the pressure is tending to fall, until amidships the water is flowing aft with maximum velocity and the pressure is a minimum. At this point, where the pressure is below the normal, there is naturally a corresponding depression in the surface of the water. In deep water it is difficult to observe this, but in shallow water it is very obvious. If, therefore, the overtaking vessel gets its bow into this depression, it tends to run faster relatively to the overtaken ship. On the other hand, if it manages to pass abreast and begins to draw away it must not only overcome the adverse current due to the water flowing aft from the overtaken vessel, but must also surmount the wave on the forward side of the depression. This position is perhaps that of maximum danger, and if the vessels are of the same size it is hard to see how they can avoid being drawn together; the best plan obviously is for one vessel to stop her engines. These phenomena of wave-making in shallow water, while more accentuated than in deep water, become still more remarkable if the vessels are proceeding through a relatively narrow channel. The reason for this lies in the fact that as the water becomes shallower the stream lines become more and more two-dimensional in character instead of three-dimensional, which tends to increase the stream-line variations of speed and pressure. That these must obviously be great in the case of a 50,000 ton vessel proceeding at 18 knots the following calculation will show:—Assume the channel to be 300 yards wide—that is, rather more than the length of the ship—and to have a mean depth of 40ft. A section of this channel equal in length to that of the ship would contain 900,000 tons of water. Passing through it at 18 knots the 51,000-ton Olympic ploughs a groove 85 per cent. of the depth and displacing nearly six per cent. of the total volume in 29 seconds. It is very probable that a big ship would not be seriously inconvenienced by this at 100 yards distance, but a small ship would feel it severely. It will be interesting to have wave-line photographs and measurements of the Olympic's side when next she proceeds through the channel at this speed. Viewed along her immense length, the vertical height will appear relatively small, but the absolute amount is such that a small ship would inevitably be affected.

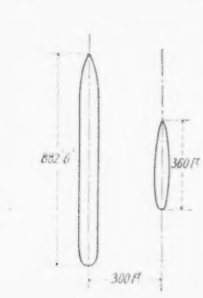


Fig. 2

NEW BRIDGES FOR EGYPT.

TRANSPORT facilities on the Nile at Cairo are destined to be materially improved by the re-alignment and opening up to navigation of that branch of the river known as the Bahr-el-Aama, and the substitution of a new road bridge for the existing Pont des Anglais, the swing span of which is now over dry land. Some three months ago tenders were invited by the Public Works Department at Cairo for the provision of this new bridge, and that of the Cleveland Bridge and Engineering Company, Limited, of Darlington, was accepted a few days ago. The following is a complete list of the various tenders submitted:—Compagnie de Fives-Lille, Paris, £E.98,263, 24 months; Sir Wm. Arrol and Co., Limited, Glasgow, £E.88,751, 24 months; Baume and Marpent, Haine-St.-Pierre, Belgium, £E.69,981, 22 months; Société John Cockerill, Seraing, Belgium, £E.63,054, 23 months; Maschinenfabrik Augsburg-Nürnberg, Gustavsburg, Germany, £E.61,413, 21 months; and the Cleveland Bridge and Engineering Company, Limited, of Darlington, England, £E.60,000, 22 months. This new bridge will accommodate road and tramway traffic, and will have a footpath 3.50 m. in width carried on each side on cantilevers outside the main girders. The distance between parapets will be 19 m. In addition to two approach spans, each of 32.60 m. in length, there will be an electrically-operated rolling lift span having a total length between centres of piers of 62.80 m. The piers and abutments will be carried out by means of compressed air, and the foundations will be at an average depth of 16 m. below lowest Nile level. The bridge will be finished in ashlar drawn from quarries in close proximity to the site of the works. The Rodah bridges at Cairo connect the city with the island of Rodah by two short spans, and the island of Ghizeh by a bridge 1775ft. long, having a swing span of 216ft. These bridges afford an excellent means of communication between that part of Cairo bordering on the old town and the road to the Pyramids on the opposite bank. The Embabeh bridge carries the railway lines across the river, and the only road bridges spanning the Nile near the centre of Cairo are the Kasr-el-Nil and the Pont-des-Anglais. Consequently, in order to get from Boulac—the industrial quarter of Cairo—to Ghezireh, a long detour has been necessary, but this disability will be removed before long, as the two new bridges, detailed particulars of which appeared in THE ENGINEER of March 13th, 1908, are now being completed by the Compagnie de Fives-Lille, of Paris.

In connection with the provision of a more direct route between Port Said and Alexandria than is afforded by the existing lines *vid* Cairo or Minet el Gamh and Benha, the Egyptian State Railways Administration is now proceeding with a new section of railway between Ziphteh and Zagazig, and contracts for the two single-swing span bridges, one to cross the Rayh Tewfikreh at Mit Gamr, and the other over the Bahr Moes near Zagazig, have just recently been awarded to the Cleveland Bridge and Engineering Company, Limited, of Darlington, the particulars of the various tenders being shown in the table:—

Name of firm.	Mit Gamr Bridge.	Time required.	Bahr Moes Bridge.	Time required.
	£E.		£E.	
Baume and Marpent	22,100	14 months	18,760	18 months
Les Ateliers Metallurgiques, Nivelles, Belgium ..	21,907	84 weeks	18,509	80 weeks
Société John Cockerill, Seraing, Belgium	20,965	20 months	17,317	24 months
Maschinenfabrik Augsburg-Nürnberg	20,216	13 months	16,789	13 months
Cleveland Bridge and Engineering Company, Limited	20,139	12 months	17,164	16 months

CABLE IN THE HARLEM RIVER.—We hear that an American company has just completed a notable cable which will be laid in the Harlem River for the New York Edison Company. The cable is in four lengths of 800ft. each, and consists of three 37-strand conductors, each of 350,000 circ. mils. Each conductor is insulated with a 13/64in. layer of 30 per cent. Para compound overlaid with tape. The three conductors are laid up in clover-leaf form, with fillers consisting of tape, an 11/64in. rubber jacket of 30 per cent. Para tape, ⅛in. lead sheath, jute bedding, an armouring of 38 No. 4 galvanised steel wires, and finally a covering of two layers of jute and tar. The cable is to be operated at 13,000 volts working pressure, and was tested for 25,000 volts for half an hour between conductors and between conductors and earth. It is about 4in. in diameter, and the shipping weight of each length of 800ft. is about 18,000 lb.

RAILWAY MATTERS.

A PRACTICAL test of the Renard road trains will be made in New Zealand, and if successful, similar trains will be put in service to provide a means of transport to the nearest railway station for settlers in sparsely populated districts. Increasing use is to be made of motor cars to connect with railways in towns not yet having railway facilities.

ACCORDING to the *Railway Age Gazette*, the Northern Central Railway, Spain, has received a concession for an extension to Logrono, in northern Spain, and is also seeking to obtain concessions for a branch to Estella and Pamplona. These extensions would penetrate a region rich in agriculture and mining products and would furnish the main line with a considerable increase in freight tonnage.

IT is reported that the Prussian State Railways are planning to electrify the suburban service in and about Berlin with single-phase locomotives despite the successful operation of single phase motor cars on the Blankensee-Hamburg Ohlsdorf lines. This decision is not only due to the fact that the present steam cars must be used, but also on account of the lower cost of maintaining one large engine as compared with eight to ten motor cars.

THE annual statement presented to the New Zealand Parliament by the Minister of Railways shows a net profit in 1910 of £1,159,113, the total earnings amounting to £3,400,887, the highest in the history of the railway department. A profit of 4.06 per cent. is shown on the invested capital. The Minister of Railways says that Parliament will be asked to sanction an expenditure of £97,330 on grade-reduction work, one-fourth of which would be spent each year for four years.

IN spite of the large orders placed during recent years with French works for railway rolling-stock, the deficiency of trucks, &c., is painfully evident, and bitter complaints are made of the manner in which certain branches of French commerce are handicapped thereby. It is now stated that the head of the State Railway recently discovered that 10,000 coaches do not answer to the requirements of the Berne Convention for international transport, and that the question of demanding a special credit of 72,000,000f. (£2,880,000) from Parliament for new rolling-stock is being considered. The Northern Railway is also about to order a large number of coaches.

WE hear that the Board of Trade have now received a copy of a report by the consulting railway engineer for the Commonwealth of Australia on the construction of the proposed transcontinental railway through South and Western Australia, from Port Augusta to Kalgoorlie. The total cost is estimated at £4,045,000, including bridges and culverts, £84,000; rails and fastenings, £1,012,000; sleepers and ballast, £1,038,000; water supply, £453 000; station yards (including telegraph equipment, terminal accommodation, and workshops and machinery), £335.000; rolling stock, £315,000, &c. If internal combustion locomotives were employed the cost would be reduced to £3,839,000, owing to the saving to a large extent of the cost of providing water.

ACCORDING to *Electrical Engineering* the conversion of the Washington, Baltimore and Annapolis Railway from single-phase 600-volt to direct-current 1200-volt working has been fully justfied by results. The higher working pressure is stated to give no difficulties. The maintenance charges for the electrical equipment are said to have fallen from 0.185d. per car mile for alternating current to 0.12d. per car mile for direct-current working. The cost of power consumed from 2.9d. for alternating-current to 1.93d. per car mile for direct-current, and the total running costs from 11.6d. to 9.5d. per car mile. The gross receipts have also increased, and the trains are said to keep much better time.

IN alternating-current railway motor work, the tendency in European practice is entirely toward the use of 15 cycles, and this undoubtedly represents material advantages over 25 cycles. In electric locomotive construction there has been a very strong tendency to depart from the gearless type; that is, those with the armatures mounted directly on the axles. In practically all the newer designs the motors are connected to the axles either by gears or side rods, or a combination of both. Each arrangement has some advantages, but either the geared or the gear-and-side-rod arrangement appears to have the preference for slow-speed locomotives. In some European three-phase locomotives, however, the side-rod construction is used even for comparatively low speeds. On large car equipments and locomotives the tendency is toward artificial cooling of the motors and other apparatus.

ANOTHER section of the London and South-Western Railway's Waterloo Station enlargement is rapidly approaching completion is a roadway and footpath from the Westminster Bridge-road to the front of the spacious booking hall of the new South Station. The new approach was opened for vehicular traffic and pedestrians last Monday, and henceforth all road vehicles arriving at Waterloo with intending passengers for departure by main line expresses and special boat trains should come into the station by way of the Westminster Bridge-road entrance, adjoining the company's railway overbridge, instead of, as hitherto, by the Griffin-street entrance, which will be closed. After setting down passengers all vehicles will leave the station by the Lower Marsh exit, immediately off the Waterloo-road. The new entrance is easily accessible from all parts of London. The main line trains leaving the new station will be for Andover, Salisbury, Yeovil, and the West of England generally; for Bournemouth, Swanage and Weymouth lines; for the Portsmouth direct line to the Isle of Wight; and for Aldershot, Farnborough, Winchester and Southampton lines. Trains also leave this station for Epsom, Leatherhead, Surbiton, Woking, Chertsey, Weybridge, Hampton Court, and other suburban stations.

IN the discussion on Mr. Dawson's paper on "The Future of Railway Electrification," read at the Royal Automobile Club on Friday, December 8th, Mr. G. W. Partridge made the following remarks with reference to the electrification of the Brighton Railway:—"The use of sub-stations means great loss. I think some of the best systems have only got an efficiency of from 80 to 85 per cent., and that is very high. Now the efficiency of our present system—and I speak feelingly, because we meter our units on the line—is 95 per cent. from the generators to the railway. When one is generating units in millions, 10 or 5 per cent. of efficiency is a great thing, a very great thing. If you take, for instance, the London County Council generating station at Greenwich, we heard the other day from Sir John Benn that the cost per unit generated there was about ¼d. Now, I think they generate about 100 million units a year, and 10 per cent. on that works out at a small figure of £10,000 a year, which is certainly worth while saving! I therefore maintain that the advantages of the single-phase system, from the point of generation and distribution, are these:—First, it is more economical; secondly, the trains being connected direct with the alternators makes it much simpler; and, thirdly—this is even a greater advantage—it is much more flexible, it can be extended to unlimited distances with very small cost. I am not speaking from hearsay of this system, because I have worked with it for over twenty-five years, and my company at present, and for some years past, has been running the two systems—that is, single-phase alternating and the direct-current system, so that I have had ample chances of comparing the two systems. On the question therefore of generation and distribution, to my mind there is only one system, and that is the one that has been shown to you so ably by Mr. Dawson to-night."

NOTES AND MEMORANDA.

MANY foundrymen, states the *American Machinist*, use an iron rod for stirring any kind of brass or bronze alloy, but where this is done more or less of the iron will be absorbed, rendering the metal harder. If it is intended to be prepared for making brass or bronze castings, graphite stirring rods should be provided. When melting any brass or bronze alloy the metal in the pot should be covered with powdered charcoal; some foundrymen use a fusible flux on top of the metal, as broken glass, borax, or a mixture of soda and sand.

IN a paper on the "Effect of Low Temperature on Edison Accumulators," the author shows that there is a critical temperature for the electrolyte, varying with the rate of discharge, below which the capacity falls to a low value; and the lower the rate of discharge the lower is the critical temperature. Recovery takes place on warming. This temperature appears, from the brief particulars given, to be 55 deg. Fah. Where necessary, automobile battery compartments are closed and supplied with heating coils, which, however, are unnecessary as soon as the battery is put to work.

FILLING holes in concrete walls left by the tie rods of the forms has been done by forcing corks into them and then ramming the holes with grout. A negro workman at one of the filter beds at New Orleans thoughtlessly jammed the cork of an empty bottle into one of the holes he was supposed to fill with grout. An engineer saw this and shortly afterward ordered enough corks to fill all the holes, which had previously given more or less trouble from leakage. Corks slightly larger than the holes were used and rammed to the centre of the wall with a rod having a collar several inches from the end and provided with a metal weight arranged so that it would slide along the rod and act as a hammer. The remainder of the hole was then readily grouted.

IT is reported in the *Electrical Engineer* that the Baugesellschaft fur Elektrische Anlagen of Augsburg has erected a plant at Bubingen which is an excellent illustration of how even small water power can be utilised for producing current for use on farms. The head is 5ft. only, and the water supply 900 gallons a second. It has, however, to be supplemented by an auxiliary machine, which takes the form of a Diesel motor. The water power, by means of a Francis turbine, works a 3000-volt kilovolt ampère generator with an exciter coupled to it. Both machines supply the same bus-bars, from which three open air wires take the current to three districts. The reduction of the voltage to 120 is effected in small transformers. The three agricultural districts supplied have a total population of only 1754 on 3200 acres, and the current feeds 700 incandescent lamps and 100 small motors, averaging 3 horse-power each. The cost of the plant was £5000.

THE *Journal* of the Washington Academy of Sciences for November 19th contains a short account of the results obtained by Messrs. Rosa, Dorsey, and Miller in a determination of the ampère in absolute measure at the Bureau of Standards. A current balance of the Rayleigh type was used, a coil being suspended from one pan of a balance so that it hung horizontally between two horizontal fixed coils of double its diameter, the three coils being coaxial. The change of weight in one pan of the balance necessary to maintain equilibrium when the current in the fixed coils was reversed was determined. The absolute value of the chemical equivalent of silver obtained by means of the balance is 1.11804 milligrammes per coulomb. The value adopted at the London Conference in 1908 was 1.11800. The electromotive force of the Weston normal cell at 20 deg. Cent., obtained by sending one absolute ampère through an international ohm, was found to be 1.01822 volts.

IN a paper on "Electro-magnetism," read before the Birmingham Association of Mechanical Engineers by Mr. R. Berry, the author remarks that in the year 1825 William Sturgeon gave to all the world the principle of electro-magnetism, and the same year invented the soft iron electro-magnet, an instrument of vast importance to the electrical engineering world. Up to that time the only known magnets were the natural one loadstone, and the steel permanent one usually U shape or often described as the horse-shoe magnet. The next step in advance was taken by Professor Joseph Henry, of New York, who, in 1831, discovered that a weak current circulating many times round an iron core produced the same magnetising effect as a heavy current circulating only a few times round the same core, which, put into modern language, means that the magnetic motive force of a coil is proportional to the product of current (ampères) by the number of turns of wire in coil; hence the well-known law of ampère turns, which is perfectly correct so long as weight of wire is the same in each case. But the author maintains, the moment it is altered, this ruling does not hold good, and this practically represents the whole theme of the paper.

IT is reported in the *Chemical Trades Journal* that Mr. Andrew Gordon French, a native of Glasgow and a well-known metallurgist, has discovered in the Nelson district of British Columbia an absolutely new element which is expected to prove of high commercial value. The new element, which has been termed "Canadium" in honour of the Dominion, is considered to be one of the platinum group of metals, and will probably take its place between ruthinium and molybdenum in the periodic table. Canadium is beautifully white and brilliant. It occurs pure in semi-crystalline grains and in short rods, and also as scales in platinum ores. It does not tarnish on exposure, nor is it oxidised on heating with a blow-pipe. It is soluble in nitric and hydrochloric acids, and in *aqua regia*. The melting point of Canadium is lower than that of fine gold and silver, and much lower than that of palladium. The new element was found in a platinum mine recently discovered by Mr. French, and from which platinum, iridium, palladium, rhodium, and osmium have been obtained. It occurs in the ore in quantities varying from a few pennyweights to three ounces per ton. We understand that Mr. Frederick Soddy, F.R.S., of Glasgow University, is waiting for a sample for examination and confirmation before the discovery is communicated to the learned societies.

AN apparatus patented by an Australian inventor is designed to enable communication to be established by night between ship and shore or ship and ship by means of light signals according to the Morse code, even though those working it are not adepts in that code. For this purpose the ship is provided with a number of metal plates, each representing a letter of the alphabet, which can be fixed to a wheel forming part of the apparatus, and which, when the wheel is rotated, by means of suitable projections close the circuit through an electric lamp, and thus cause it to flash out the dots and dashes corresponding to the letters. To use the apparatus the sailor consults the international signal book, picks out the letters which stand for the message he wishes to send, fixes the corresponding plates on the wheel, and pulls a lever which both sets the wheel in rotation and switches on the current to the lamp, either from the ship's dynamo or from a battery. The apparatus then continues to send the desired message automatically without further attention until it is stopped. As the signals are shown comparatively slowly, and are repeated at each revolution of the wheel—or oftener if duplicate sets of plates have been fastened to the circumference—any one on another ship ought to be able to decipher them by reference to a Morse alphabet; and then, having made out the letters, whatever his nationality, he has only to consult his international signal book to discover the meaning of the message.

MISCELLANEA.

A PROCESS has been invented by Mr. N. K. H. Ekelund, who is well known in the Swedish peat industry, for the reduction of iron ore in the electric furnace, using peat powder as fuel. This powder is mixed in equal quantities with crushed iron ore, and the gas generated by the reduction is diverted and made use of to produce the electrical energy.

THE first meeting in Edinburgh of the newly formed Scottish Local Section of the Institution of Electrical Engineers was held last Tuesday, in the Heriot-Watt College, the chairman of the section, Mr. F. Newington, in the chair. A paper was read by Professor Baily, on the equipment of the electrical engineering laboratory at the Heriot-Watt College.

A GERMAN at Sarona, in Palestine, has lately begun the manufacture of olive oil with a European machine, the seeds not being roasted but simply crushed and pressed. The resulting oil is much lighter in colour and commands a better price, but it is stated that by this process less oil is obtained from the same amount of seed than by the native method.

THE Spalding Rural District Council has completed its purchase from the receiver of the South Lincolnshire Water Company, of that part of the undertaking included in the Spalding Rural District. The purchase price is £2500, and it includes the well at Pinchbeck West and the mains as far as the parish of Whaplode. The mains, it is suggested, will now be extended so as to cover other parts of the Spalding Rural District, and there are extensions proposed in Moulton, Moulton Chapel, and Moulton Seas End, and also to Cowbit and Surfleet. The undertaking, therefore, will involve considerable outlay beyond the initial cost of the work.

THE use of copper sulphate to destroy micro-organic growths in the water supply of Newark, New Jersey, was commented upon by Mr. Morris R. Sherrerd in an address at the recent annual meeting of the New Jersey Sanitary Association in Lakewood. Newark, he said, has been troubled most by the presence of synura, and it has been found advisable to use one part of copper sulphate to 6,000,000 parts of water. In applying the chemical the former practice was to place the copper sulphate in feed bags and allow them to drag in the streams at the end of a rope, but the newer method is to dissolve the chemical in water and apply the solution to the streams.

DURING recent years there has been considerable increase in speed in 60-cycle synchronous converters, until at present these speeds are approaching very close to those of direct-current turbo-generators, especially in the case of 600-volt machines. Further increase in speed in 60-cycle converters probably will have to be accompanied by more or less radical departures in the design of such machines. In 25-cycle converters there is still room for increase in speed, especially in the higher voltage machines. When the ultimate limit in speed is reached it is possible that interpoles will be used to a considerable extent, especially in those machines which have a wide range in load or where the peaks are very high compared with the average load.

THE steamship Demerara was launched at Belfast yesterday (Thursday) by Harland and Wolff, Limited. It has been built for the Royal Mail Steam Packet Company. During the twelve months the firm has completed ten vessels with an aggregate tonnage of 118,209, which is the largest output of any single firm in one year in the history of shipbuilding. It is stated that Harland and Wolff for the thirteenth year head the list of shipbuilders, while the horse-power of the ten vessels, aggregating 97,000, is also the highest on record. The largest of the ten vessels was the White Star liner Titanic, now approaching completion. The previous record for highest output was held by Swan and Hunter, of Tyne, whose tonnage in 1906 was 117,943.

THE British Fire Prevention Committee has issued a report on the fire protective arrangements in Paris. Besides giving a detailed record of what the Commission considered instructive, the report is prefaced by a number of observations and impressions which should be of considerable importance to the fire protective work in this country, as also in the Colonies, the data being prepared in such a manner as to be of use to the various authorities concerned. The Paris Fire Brigade Regiment is dealt with at considerable length. This brigade is fast becoming a motor fire brigade. The fire preventive measures as to shops, warehouses, theatres, and tube railways are dealt with in detail. The national fire service, the Paris suburban fire brigades, the fire precautions at great establishments outside Paris, like those of some of the great gasworks, are fully reported upon; as is also the organisation of the French Fire Service Federation. The whole subject is reviewed with reference to both the national and local aspect, and the illustrations are supplemented by a coloured map of Paris.

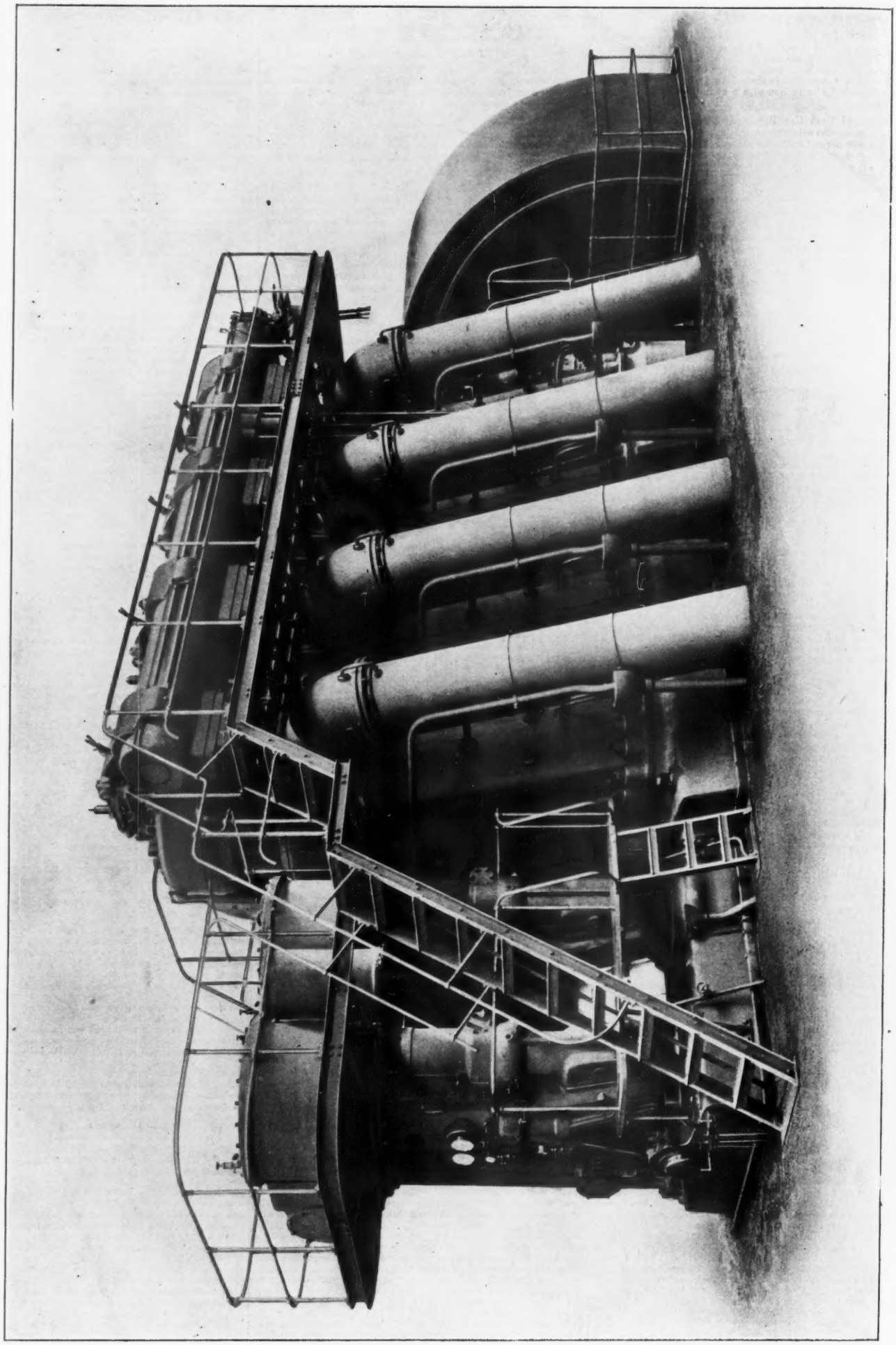
OUR contemporary, the *Electrician*, calls attention to the affinity which the white ants of Australia seem to have for cables. It is stated that in one case near Adelaide it has been necessary to remove a section of a telephone cable, the condition of which leaves little reason to doubt that white ants have eaten away both the lead covering and the insulation. The cable in question consisted of 100 pairs of paper-covered wires. Similar troubles have occurred on the cables supplying energy to the Sydney tramways. These cables were laid on the solid system. The ants, however, got through the bitumen compound and then attacked the lead sheathing, finally eating into the insulation of the high-tension cables. The authorities thereupon decided it was necessary to provide poison for the termites, and the bitumen in which the cables were laid was therefore mixed with half an ounce of arsenious oxide to a cubic foot of bitumen. The same procedure was followed at Adelaide, where a specially strong mixture, consisting of half a-pound of arsenious oxide per cubic foot of bitumen, was also run in a thin layer along the top of the trough after the main bulk of the bitumen had cooled off. The ants appear to work very quickly, for cases have occurred in the main street of Adelaide where the Jarrah wood blocks—supposed to be white-ant proof—that are laid between the tramway lines have been absolutely riddled in 2½ years.

NEW movements which have ultimately been of great commercial benefit have had their origin in Birmingham, and a project has now been set on foot for the standardisation of screwed copper tubes. The Birmingham and District Branch of the National Association of Master Heating and Domestic Engineers has drawn up a scale of tables of standardisation which will be submitted for consideration at a meeting of the Joint Committee of the National Association and of the Institution of Heating and Ventilation Engineers. Should the suggested tables, which are of three grades, namely, for light, medium and heavy work, be adopted, they will be forwarded on to the National Engineering Standards Committee. Should that committee adopt them either in their entirety or with alterations, they will then be put into general use; but in the meantime it may be mentioned that the Birmingham Branch of the National Association of Master Heating and Domestic Engineers has determined to make use of them and test their practical value, though no apprehension of their general utility is felt. They have been carefully thought out and drawn up on lines as nearly as possible to the standards now applicable to iron tubing, and after consultation with eminent engineers in the biggest manufacturing and commercial centres of England, such, for instance, as London, Newcastle-on-Tyne, Manchester, Liverpool, Bristol and Leicester, representatives from which are members of the Joint Committee.

2400-H.P. TWO-CYCLE DIESEL OIL ENGINE

SULZER BROS., WINTERTHUR, ENGINEERS

(For description see page 629)



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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

MEETINGS NEXT WEEK.

(*See "Forthcoming Engagements" page* 648.)

THE ENGINEER.

DECEMBER 22, 1911.

Suction and the Steering of Ships.

THE question whether or not there is "suction," as it has been termed, between two ships in close proximity to one another assumed an important aspect in the evidence given at the inquiry into the Olympic-Hawke collision, and although the judge has been very cautious in his handling of the matter, for he was enabled to come to a clear decision without making dependence on it, yet it has been brought so prominently before engineers and shipbuilders that it is bound to be studied closely in the near future. That such a phenomenon is a real one is an undoubted fact, in spite of expert evidence which seemed to discredit it, for it is often observed to take place between a ship and the ground over which it is passing. Vessels which run in very shallow water are said to "seek the bottom," and sometimes in restricted waters to "seek the bank." The prime cause of this is the effect of stream-line action of the water surrounding the ship. This is a dynamic force produced by the motion of the particles of water on the stream lines. With vessels running in shallow water, over a sand-bank, for instance, it is frequently noticed that the keel may touch the bottom when the water is deeper than the natural draught of the vessel, even when allowance is made for the squat or trim by the stern proper to the speed in deep water. This "seeking of the bottom," as sailors call it, is often experienced in Eastern rivers where there are long stretches of sand-bank and shallow depths of water, and is explained by the fact that the ship when being driven through the water has continually to displace an amount of water equal in volume to the immersed portion of the hull; the wedge shaped entrance cleaves the water and forces it to take the line of least resistance in order to get out of the way of the advancing body of the ship. Part of it goes round the ship, and part is forced under the bottom in more or less diagonal planes.

This motion has been very clearly demonstrated in the beautiful experiments made at Washington for the express purpose, which we have before referred to, and which are dealt with again on another page. When the water is free to take this motion in unlimited depth, a system of pressures upon the hull is set up, due to the velocities of the particles of the stream lines flowing past it, and these pressures produce a certain "squat" or "trim" natural to the particular ship at the particular speed of advance. If, however, the ship be running in water of very limited depth, the stream lines which go under the bottom are forced along what may be looked upon as a flat pipe of comparatively small diameter, and the resulting increased velocity of flow causes a corresponding decrease of hull pressures along the bottom, and the vessel consequently sinks in the water, hence the phenomenon known as "seeking the bottom." A familiar toy illustrates the action accurately. The toy is a pipe with a coned mouthpiece. If a light ball be placed in the cone it cannot be blown off by driving air through the pipe. The reason is that the air, as it issues through the narrow space left between the ball and the cone, increases in velocity and reduces in pressure, with the result that the ball is actually drawn down. Now, suppose instead of a limited depth there be a limited breadth of water on one side or other of the ship, such as would be caused by passing close to a quay wall, then the same "suction" or "seeking" will take place but in the transverse direction, drawing the ship bodily sideways instead of vertically downwards. It should be noted, however, that the centre of rotation of a ship when turning under her rudder is always considerably in advance of her centre of gravity, so the effect of the suction is not to draw the ship bodily towards the wall in a parallel direction, but to cause her to swerve; this effect is well known to pilots of narrow waters, and they counteract it by using the rudder. Let us suppose the wall to be replaced by a large ship proceeding in the same direction as that of the ship under consideration. Here we have a similar but more complicated case, for the stream lines which have been produced by the clearing action of the bow of the large ship have their counterpart in a corresponding action at her stern, as the stream lines close in around the fine after end. This action in the transverse action is more or less marked according as the run of the ship is more or less full, and the speed more or less great. Let us further suppose the smaller ship to be overtaking the much larger one, the large ship being on the port bow of the small one, both going in the same direction; as the overtaking ship approaches the starboard quarter of the large ship she comes into the region of influence of the stream lines flowing in around that vessel's stern, and there is a tendency for the bow to be drawn with more or less force toward the quarter of the ship she is overtaking, and if no correction be applied by means of the rudder, there is danger of collision, for the stern of the leading ship is subject to a force tending to draw it toward the overtaking vessel. Such a case occurring in narrow waters may cause the leading ship to sheer to port, because the stern is drawn over to starboard, and there may be danger of forcing her ashore on the port side if the speed be slow and the counteracting effect of the rudder consequently small; it is evident from this that if a collision occur under such circumstances, the angle of impact will be an acute one, and not at all approaching a right angle. Suppose, now, the overtaking ship to have got safely past the quarter of the leading ship, and to be abreast of her, and the relative speed of the ships is now changed, either by the leading ship increasing or the overtaking ship decreasing speed, so that the smaller ship becomes the slower, and therefore falls back relatively to the larger; the effect upon the steering of the smaller ship, as her stern comes into the region where it is affected by the suction, will be first to cause her bow to turn to starboard and away from the larger ship, but as she falls further back her stern will pass more and more out of the drawing influence of the stream lines, the bow will become in its turn affected by suction and will turn to port toward the larger vessel. If the ships are in close neighbourhood there is again danger of collision if the smaller ship should attempt to cross under the stern of the larger vessel, and be thus brought into the immediate action of her wake. Such close proximity would be carefully avoided according to all the rules of good seamanship, and such a sphere of indeterminate influence given a wide berth, for it is possible that the diameter of the turning circle of the smaller ship would be much increased, and that she would fail to turn in her normal curve with the helm hard over, the result being possibly a more or less end-on collision with the larger vessel. We are not, of course, suggesting that there is any direct resemblance in this assumed condition to what happened in the Hawke-Olympic collision. In that case the judgment is clear that the smaller ship, the Hawke, was not endeavouring to turn under the stern of the Olympic.

The actual fact of suction between two vessels under way is indisputable, but the actual value of the force and its radius of influence is difficult to estimate; what precise degree of approximation is necessary in order that the suction shall have so great an effect as to neutralise wholly or in part the turning moment exerted by the rudder is problematical in the extreme. Experimental tests with models are not altogether satisfactory for the purpose; a model when being towed and free to move in a transverse direction will not travel steadily in the straight line passed through by the tow point, but tends of itself to swerve from one side to the other owing to instability of the conditions. When resistance experiments are made with models, these are constrained to move in a straight line by means of guiders which confine swerving to an exceedingly small amount; towing two models then without guiders, and in close proximity to one another, must be a doubtful method of ascertaining the tendency to attraction between them; while if guiders be used, the purpose of the experiment is defeated unless, as may be done, means are adopted to measure small changes of force upon the guiders, and this only partially covers the case of two ships moving under their own power, subject to rudder influences, and changing their relative positions all the time. Mr. D. W. Taylor has evolved quanti-

tative figures to express these suction influences, and the probable radius at which they are operative, but they must obviously be largely dependent on many variables, such as displacement, form, and speed of ships. While these forces may be very considerable between ships at very close range, it must be remembered that they also decrease very rapidly with increasing distance, and therefore there seems to be no valid excuse for two ships on the high sea, in broad daylight, ever coming into positions where such a force as suction between them can be of the smallest moment. That there is some excuse for navigators at the present time bringing their vessels into dangerous proximity has been made clear by the contradictory evidence on the effect of suction. Experiments, so far, have not been carried far enough or attracted sufficient attention to enforce themselves on the minds of seamen. But the matter cannot now be left where it is. It must be pursued further, and in view of its nature it is pre-eminently a subject which should be taken up by the National Tank. It must be a source of great satisfaction to Mr. Yarrow that almost in the first month of its existence his tank has been called upon to deal with a question of the kind and of such importance. But his satisfaction, we feel sure, will be only half complete if the experiments are not pushed onwards until all the enlightenment that tank experiments can afford has been obtained.

The Trustworthiness of Mild Steel.

THE interest of Mr. Stromeyer's "Memorandum," or annual report for the year 1910, as chief engineer to the Manchester Steam Users' Association, centres in an account of certain experiments which he has carried out to obtain information concerning the properties of mild steel. It is a special characteristic of steel that it is an inexhaustible subject for investigation and inquiry. There is no evidence to show that there is a limit to the discoveries which can be made concerning it. Every research produces something new—whether valuable or not as practical information remaining, it is true, to be seen. Mr. Stromeyer's inquiry has been no exception to the rule. If he has discovered nothing obviously new, he has, at all events, developed and consolidated existing information; and his results claim consideration from all who have any practical concern with steel as a constructive material.

The old question of the true value of tests for steel is that really considered. We have the analysis, or chemical test. The mechanical test, under various titles, and the temperature test. "The usual test conditions," writes Mr. Stromeyer, "are that the steel for boiler plates must be produced in the acid open-hearth furnace, and that it must withstand the temper bending test as a proof that a certain percentage of carbon is not exceeded. Its tenacity is fixed by certain limits, and its elongation must exceed a certain percentage, and it is then assumed that carbon and manganese are present in their right proportions, and that the other impurities do not exceed certain limits. Some engineers also make cold bending tests, of which it is assumed that they will indicate whether or not the material has been improperly heated during the process of manufacture. None of these tests are capable of detecting such steels as contain excessive percentages of phosphorus or nitrogen, elements which are now known to make steel quite untrustworthy." He goes on to consider further the curious and so far wholly inexplicable fact that caustic soda ruins mild steel when in tension, while it has no injurious effect on it while in compression. The fact, if fact it is, shown by Mr. Heathcote, that mild steel absorbs liquids may possibly throw some light on it. His experiments add, however, very little to the small amount of information already in existence, which teach that the density of caustic liquor should not be permitted to exceed about 70 deg.—Twaddle.

There is an apparent inconsistency in the report. From the passage which we have quoted it will be seen that nitrogen is classed with phosphorus as an element known to make steel quite untrustworthy; yet we find further on a reference to the experiments of Mr. Braune, a Swedish chemist, with steel containing various proportions of nitrogen. Considerable variations in the percentage of this element were discovered in Mr. Stromeyer's test pieces, which it was found had higher tenacities than those that could be calculated from the chemical analysis already carried out, which apparently did not include a test for nitrogen. That is to say, high percentages of nitrogen improved instead of injuring steel. A co-relation is established between the chemical analysis and the tensile test. Nitrogen, indeed, it would appear, is an important factor, about eight times more powerful than carbon in imparting increased tenacity to mild steel. The next step was to divide the sample into two groups, of which all the untrustworthy steels went into one, and all the trustworthy into another. Bessemer steels rich in nitrogen head the list. Then come two open-hearth basic steels with a high percentage of nitrogen. Mr. Stromeyer deduces that chemical analysis is a safer guide than the usual mechanical tests as to the trustworthiness of any particular sample of mild steel. It appears to us that all this, and a good deal more, go to show that nitrogen does good, not harm; yet we find further on various cases used to prove the contrary. One will suffice. "Some continental angle iron, intended to be used in small portable locomotive boilers, failed in the boiler shop; the analysis showed that this steel contained 0.0146 per cent. nitrogen, which fully accounts for the brittleness." We have thus two definitely contradictory statements. The only way of reconciling them is to introduce the quantity factor, and take it for granted that Mr. Stromeyer means that when some maximum percentage—not stated—is exceeded nitrogen does harm, while below that it does good. It is to be regretted that the report is silent as regards the percentage. The formula on page 6 and the table on page 7 do not settle this point. Numerous tests of various kinds were made to ascertain the results of different methods of treatment, as by heating to various temperatures, ageing, nicking, &c. The prominent lesson taught, as we interpret the results, is that no definite relation appears to be established between quantity, composition, temperature, or any other two factors, in which the investigations follow the old rule of negation. The general conclusion is that the existing custom with boiler makers of buying plates from steel makers whose reputation is high, and trusting to the punishment of the plates in the boiler shops for the detection of impure quality, is the best. As experience extends it is more and more clearly demonstrated that no system of all-round test of quality exists that can be considered conclusive. Take, for example, the bending test. Mr. Stromeyer finds that after shearing, if the sample is bent with the fins inside, the plate may be bent double. If with the fins out it will break at a moderate angle. The question then once more comes up, what is the definition of a trustworthy steel, seeing that its manifestation of characteristics depends on the nature of the test to which it is subjected? The behaviour of the metal varies with the mechanism of the test. As plates once made into a boiler, for example, are no longer submitted to bending stresses, why should a plate which has a high tensile strength be rejected because it will not bear bending double half-a-dozen times? Steel bars and plates in practice have to withstand certain stresses, the direction and amount of which are known. It does not seem reasonable that a material which will comply with all possible demands with these stresses should be rejected because it will not comply with others to which in the course of its natural life it will never be subjected. Mr. Stromeyer has indeed undertaken his experiments in the hope that he might hit upon some simple tests on which engineers might rely for discriminating between good and bad steels, "for it is a common experience that when a plate has proved itself to be untrustworthy by fracturing, the usual mechanical tests to which it is then subjected hardly ever give any indication that the material was bad." So far as we can see he has absolutely failed to devise any tests of the kind. One practical difficulty meets us from the first, namely, the precise meaning of the words we use. Take "brittleness," for example. A plate tested in one way breaks off short like glass: tested in another way it bends double. Is the plate brittle or tough? Is it fit for making boilers or is it not? In the old days, when wrought iron was used, very little trouble was experienced in getting material the quality of which was well known. Lowmoor could not be bad, because the ore and coke were pure, and only cold blast was used. The makers, prizing their reputation, took care that sufficient "work" was put into each plate and bar. The plates would bend double cold. They would punch close to the edge without splitting or cracking. Generally the nature of B, BB, and BBB Staffordshire iron was well understood. The introduction of Bessemer steel introduced all the modern troubles, and so far it does not appear that in the matter of tests we have the smallest prospect of getting out of them.

"Fortunately," says Mr. Stromeyer, "bad steels are usually detected in the boiler shop, and very few cases are known in which boilers have failed after being put into use." But he very reasonably adds that these conditions are not satisfactory; and holds that it is most desirable that something should be done to make it possible to submit steel to tests which would teach instead of mislead. That such tests exist, as we have said, there is no indication. It would seem, indeed, that they never can be devised until such time as we limit the range of qualities over which they extend; or ascertain what is the definite mode of their operation. This last is a question which has received not nearly the attention which it deserves. Half a century ago Kirkaldy startled the world by showing that the grain of fracture in a bar of iron depended for its character on the way in which the bar was broken. Chisels being ground have broken in two, apparently because of vibration, the tops being, as it were, shaken off. These and various other phenomena have never yet been made the subject of thorough inquiry. Possibly they are inexplicable. It is, at all events, clear that Mr. Stromeyer's efforts have so far helped us very little; perhaps his and other inquiries proceed on wrong lines. We are trying to do impossibilities. Steel is a most obliging material; it will behave almost as we please under test; it is all things to all men. The great difficulty about it is all centred in Mr. Stromeyer's re-statement of the well-known fact that after a plate or a bar has broken, no mechanical test will explain why it broke. The failure is, in a word, unreasonable—an act, so far as can be seen, of caprice. Happily, steel is after all a very much more trustworthy material in practice than those who make experiments with it would have us believe.

A Leakage of Gold.

IN an article appearing in our issue of September 15th last, under the heading "A Leakage of Gold," we dealt with the matter of the East Rand Proprietary Mines, Limited, confining ourselves to the information given by the directors in their circular to shareholders dated 2nd September, 1911. A Commission was appointed by the Union Government to investigate and report on the reputed fall of ore yield and recovery of gold, and the causes that occasioned the decline in the shares of the company, and the full text of this report has now reached us. In the circular of September 2nd it was plainly stated that the gold had gone into the reduction plant, but that in the recovery there was a very serious loss, necessitating a temporary reduction of the dividend to 30 per cent. per annum instead of 40 per cent. regularly paid to that date. This naturally led to our treating the whole thing as a matter of mechanical interest, and from a purely engineering standpoint. At the time our article was largely quoted in South African journals and appreciated in unstinted terms; but the report which is now public property shows that all our deductions were based on statements which were entirely wrong, and that the reduction plant was not at fault, but that the gold had never gone into it. When the amalgamation of the various companies into what is now the E.R.P.M., Limited, took place in 1908, it was confidently stated that dividends of 40 per cent. per annum were ensured for thirty years, and up till the end of 1910 this forecast was realised. Ore reserves of the value necessary for a 40 per cent. dividend were said to be equal to five years' requirements, and development work was supposed to be proceeding at sufficient pace to keep this huge reserve intact. But as a matter of fact the ore value has fallen steadily from 31s. 6d. per ton in 1908 to 25s. per ton this year, and it is clear from the stern facts elicited by the Commission, and the company's recent returns, that, for the present at any rate, the dividend earning capacity of this huge concern is reduced to not more than 20 per cent. per annum. The report deals with the manner in which the management and the directors acted in their vain endeavour to right matters. The "clean up" which should take place on the first of each month was postponed from one day till another, until it was as late as the thirteenth, and this despite the fact that a complete return was always made to the Chamber of Mines on or before the tenth. When this policy of postponement would no longer avail, and the gold reserve had been used up, excessive cleaning up was resorted to, and so the plant was depleted of its gold and consequently of its recovering powers. Even some of the directors were for a time ignorant of this, and, of course, the public knew nothing of the gigantic effort to rally the output. Engineers of great experience were concerned in the matter, and the very fact of these measures to rally the affair being taken shows that they believed rallying to be possible. Many will sympathise with them, but the lesson is on the surface. Whatever the convictions

of a management, the actual facts promptly and fully made known will alone be its safety, and that of those who entrust great matters to its care.

Military Aviation,

THE recent announcement of the conditions governing the forthcoming War-office competition for British and foreign-made aeroplanes may be taken as indicating that the Government has at last abandoned the "waiting" policy, and that for the future it will devote itself energetically to the cultivation of aerial science as applied to warfare. If at the same time we may regard the competition as a sign that the naval and military authorities are beginning to realise the futility of the dirigible balloon in practice, and the real possibilities of the aeroplane for the purposes of war, then there is every reason to hope that the history of the British military aeroplane will follow a similar course to that of our Navy's submarines. Other countries, and France in particular, have been developing the aeroplane while Britain has stood looking on. We are now assured by the Under Secretary for War that this country is to give up its observational mood and to develop the subject for itself in the light of the experience gained by watching others. The policy may not be very noble, but it is diplomatic. It paid us to wait ten or twelve years ago while others were developing the submarine and it will pay us on this occasion too. Our submarines to-day far outclass those of any other navy, not excluding that of France, the parent of the craft. The French army is at present vastly superior numerically over any rival in the matter of its aeroplanes and skilled pilots. But if our own Government has, as we hope, realised the true importance of the matter, France is once again likely to be robbed of its superiority. As regards the War-office competition itself, it is generally agreed, we believe, that the conditions laid down, although stringent, are thoroughly practical and free from the somewhat academical features of the recent similar French trials. The military aeroplane has to fulfil a widely varying range of duties. The qualities of strength, speed, weight carrying, and long-distance flying are, separately or in combination, all required sooner or later, and in the present state of the art it does not seem possible to embody them all in the one machine. Specialisation will be necessary at first. But given a reasonable amount of encouragement from the Government, British aeroplane constructors will, we are certain, be capable of making as much progress within the next few years as that which has marked the development of the submarine during the past decade.

INSTITUTION OF MECHANICAL ENGINEERS.

THE third monthly meeting of the Institution for the present session was held last Friday night at Storey's-gate, S.W., the President, Mr. Edward B. Ellington, being in the chair. The proceedings opened with the discussion on Mr. J. H. Wicksteed's paper, "Double-cutting and High-speed Planing Machines," which was read at the last meeting, and reprinted on page 546 of our issue for November 24th.

After the usual formal business had been transacted, Mr. Wicksteed presented a *résumé* of his paper and exhibited some steel shavings, the product of one of the planing machines dealt with. The material from which the shavings had been produced was, he said, a compressed steel ingot of 40 tons tensile strength. The cutting of this steel required a pull on the table of about 12 tons. The rate of cutting was 20ft. per minute, and the horse-power of the motor driving the machine was 20. To overcome a resistance of 12 tons at a speed of 20ft. per minute, work had to be done at the rate of 240 foot-tons per minute. The motor at 20 horse-power could do work at the rate of 293 foot-tons per minute. There was thus an ample margin of power left in the motor for dealing with friction and inertia. Answering an inquiry from Mr. W. H. Patchell, he said that the material was removed at the rate of 7 lb. per minute, and that the area of the cut was one-tenth of a square inch.

Mr. L. Pendred, being invited to open the discussion, dwelt upon what he considered was the most important reason why double-cutting planing machines had not been more generally adopted. He considered that in this matter Mr. Wicksteed was his own worst enemy. In the old days when the speed of the return stroke was never more than twice that of the cutting stroke, double-cutting certainly would have been of great advantage. Mr. Wicksteed himself had, however, improved the ordinary single-cutting planing machine in a wonderful manner. He had greatly increased the ratio of the speeds and had consequently diminished the time lost on the idle return stroke. He had also invented the regenerative reverse motion described in the paper, whereby not only was the speed still further increased, but the power lost at the reversal of motion of the table was considerably reduced. Captain Tresidder had found in the course of some experiments which he had made in 1900 at Messrs. John Brown's Works that when cutting at 9½ft. per minute and returning at 19ft. the power required on the return stroke was equal to that on the cutting stroke and lay between 7 and 8 horse-power. But at the reversal of motion at the end of the cutting stroke the power rose momentarily to 14½. The reversal at the end of the idle stroke caused the power to rise to as high as 29 horse-power. Mr. Wicksteed's regenerative device got over these fluctuations in the power absorbed. The diagram reproduced in his paper showed that the rate of consumption of energy was practically constant with his machines. Mr. Pendred then dealt with what he urged was a mechanical defect of the double-cutting planing machine. During the forward cutting stroke in such a machine the reaction on the tool pressed the saddle on to the cross shears; the whole face of the shears was therefore available for taking the thrust. But on the return cutting stroke the tendency was to pull the saddle off the shears, as shown by the dotted line in Fig. 1. It did not seem wise to stress the edges of the

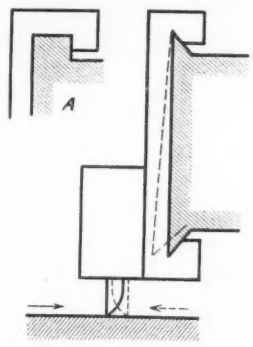


Fig. 1

cross shears in the manner indicated. Commenting on Mr. Wicksteed's modification of the Mitchell drive, he remarked that it seemed to him to attain an ideal sought by planer machine makers—a broad belt and small diameter pulley.

Mr. J. E. Darbishire, the next speaker, related some details of his early experience with planing machines. He had, he said, in days gone by been connected with the firm of Sharp, Stewart and Co., at the Atlas Works, in Manchester. This firm, as members knew, had formerly been Sharp, Roberts and Co. When he joined the works there were two planing machines in use, which had been made by Richard Roberts himself, and in which the tables were driven by chains. These machines, he might add, remained in use up to 1880.* They also had some rack-driven and some Whitworth screw-driven planing machines, with "Jim Crow" tool-boxes. About 1864 Sellers brought out his improved planer, driven by a "spiral pinion," or quick thread worm. In contrast with the old screeching machines, the new machine was a wonderful improvement. There was neither backlash nor noise. His firm took up the sole agency for the tool in this country, and from that date onward no more machines of the old type were made. Some of the first Sellers machines made in Manchester were supplied to the Barrow shipyard. Ten or twelve years afterwards a fire occurred in the shops, and the planers were damaged. The machines were returned to the Atlas Works for repairs, and it was found possible to use the original pinions and racks. There had been practically no wear, and the repaired machines were as free from backlash and noise as they had been originally. He might add that after the patent rights for the Sellers drive had expired, one of the first to recognise its advantages and adopt it was the author of the paper.

Mr. Richard W. Allen remarked that, in his opinion, works managers did not really disapprove of the principle of double cutting. But there was a fashion in engineering just as in ladies' hats. It had been customary to do jobs on the single planer, and until the vogue changed they would be continued to be done on this type of machine. Apart from this, it was clear that small work varying greatly in shape could not advantageously be done on the double-cutting planing machine. But for larger articles all alike he was of opinion that it did pay to employ this class of tool. He had recently seen the shells of Yarrow boilers being so planed on a machine specially designed for the purpose, and a great saving of time was the result. He had been studying the Vickers electrical drive for several years. In a case within his knowledge a planer having a table 16ft. long by 8ft. wide was originally driven by a screeching belt. Five or six years ago the Vickers drive was adopted. The improvement was great, but there were still some slight defects. For instance, the bicycle chain used in the apparatus for operating the electrical switches was liable to stretch, and under some circumstances this might result in the table running right off the shears. All electrical drives, he held, should be simple and have as few parts in their composition as possible. He had been at Philadelphia in the early part of this year, and in conversation with Messrs. Sellers he had learnt that they did not altogether approve of the so-called electrical reverse. They preferred in fact, to reverse their machines through clutches operated by the compressed air supply of the works. This, however, was open to the objection that it made the machine wholly dependent on the air system. The planing machine was, in truth, one of the most difficult of tools to drive satisfactorily.

Mr. Walter Deakin, of Messrs. H. W. Ward and Co., Birmingham, said that, although he was not a maker of planing machines, he was greatly interested in them, and was a convert to Mr. Wicksteed's principle of double cutting. He believed that the prejudice against the double-cutting planer was due to a want of consideration of the subject in a fair and square manner. About 75 per cent. of the jobs in an average engine shop were really suitable for the double-cutting machine. In most shops there was sufficient work to keep a double planer fully employed. Mr. Deakin then passed on to describe a double-cutting tool-box manufactured by his firm. The device is probably already familiar to some of our readers. It was illustrated and described in our Machine Tool Supplement of December 11th, 1903. Briefly, we may say that the tool used with this box is of the form shown at A, Fig. 2—that is to say, it is double-edged, the flanks being undercut to give the necessary clearance. At the end of each stroke the tool-box gives a rocking

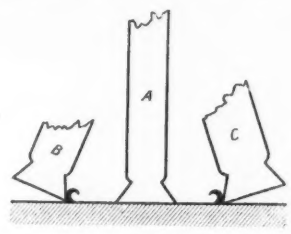


Fig. 2

motion to the tool, so that when going in one direction it is cutting as shown at B, and when returning in the other it is cutting as at C. The motion of the tool-box producing this displacement of the tool is derived from a rocking shaft actuated by the feed motion of the machine. The exact adjustment of each edge is separately under control, so that both may cut to the same depth. With the above rocking about a horizontal axis clamped, the tool-box can be arranged to give a similar semi-rotation about a vertical axis, so that side planing can be effected with a suitably formed tool. The device also lends itself to undercutting, and to all other forms of work within the capacity of the ordinary tool. It is held that for undercutting this tool-box is superior to the milling machine. Mr. Deakin remarked that the device overcomes many of the objections commonly urged against double cutting. Commenting on the remarks which had been made on the tendency of double-cutting planers to pull their saddles off the cross slides on the return stroke, he said that this was not a formidable objection. Indeed, an examination of the true state of affairs caused the objection entirely to vanish. When the table was going from left to right—see Fig. 1—the saddle was certainly pressed against the lower edge of the cross slide, but it was pulled off at the top edge. The reverse stroke only reversed matters, and did not bring new conditions into play. In both strokes the cross slide was really subjected to torsion, and it was easy enough to design it so as to be strong enough to resist the torsional forces in whichever direction they acted.

Mr. Charles Wicksteed stated that it was wrong to seek the reason for the non-adoption of double-cutting planing machines in the existence of mechanical defects in the principle. The reason really lay in the intense conservatism which permeated the whole engineering profession. Unless he had been aware of the fact that the rate of progress in adopting new proposals in this country was extremely slow, he would have been most profoundly astonished that his brother's ideas on this subject of double cutting had not been more generally accepted. Engineers were very like a flock of sheep, they followed one another's lead. In this case, in spite of the many undoubted advantages of double cutting, opinion was against it, and it would be difficult to turn the flock into another fold. Yet it was certain that double cutting increased the output and the speed of production. It also reduced costs, and incidentally increased the available shop room.

Mr. W. H. Patchell renewed his request for further information regarding the size and depth of cut removed by the author's machines. There was no advantage, he said, in speeding up a machine if no more metal was removed. Mr. Wicksteed seemed to be a strenuous advocate for the employment of jockey pulleys. He himself had had some unhappy experiences with such pulleys, and doubtless other members of the Institution had been no more fortunate. The belts employed with

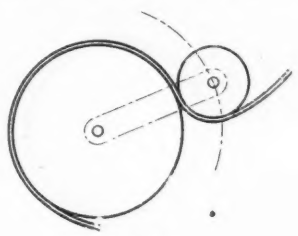


Fig. 3

jockey pulleys were ordinarily of the link type. A link belt, besides being heavy and otherwise abominable, was after all only half a belt. To get the same strength the width of a link belt had to be double that of a solid belt. He would add, however, that when in Germany recently he had seen a French machine running very satisfactorily with jockey pulleys on the belt.

Mr. A. W. Marshall commented upon the change in ideas which had taken place recently with regard to the best shape for planing and other machine tools. Rigid tools had, he said, replaced those formed with a bend and

* Our readers may remember that a short time ago we published illustrations and particulars of two old lathes made by Roberts, one in 1817, the other in 1820. The latter was still at work in 1910 at Messrs. Beyer, Peacock's Works. See THE ENGINEER for October 21st, 1910.

capable of springing to a small amount. Referring to the last speaker's remarks about jockey pulleys, he was understood to say that the drive mentioned by Mr. Patchell was in his belief that known as the Lennox. In this the jockey pulley could swing concentrically with the axis of the main pulley—see Fig. 3. The device was extremely successful.

Dr. H. S. Hele-Shaw said that he had been scaling the drawings of Mr. Wicksteed's machines given in the paper and found that roughly the height from the table to the top of the cross slide could be divided into three equal parts —see Fig. 4. Calling the reactions of the shears R_1 and R_2 and the force on the point of the tool F, then we had $R_1 \times h = R_2 \times \frac{1}{3} h$, or $R_1 = \frac{1}{3} R_2$, and therefore $R_1 = \frac{1}{6}$ F. It therefore did make a very great difference in which

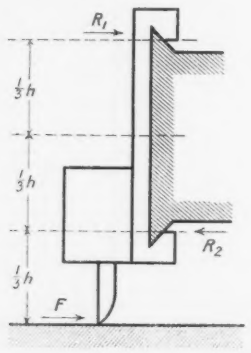


Fig. 4

direction the cut was made. He knew it was dangerous to introduce calculations into such a discussion, but he felt that this argument was sound. A few minutes later Dr. Hele-Shaw attempted to reach the blackboard without attracting notice. Amidst much laughter, he changed "$\frac{1}{6}$" into "$\frac{1}{3}$," so that his last equation read: $R_1 = \frac{1}{3}$ F.*

Professor Robert H. Smith remarked that spring tools had been given up for accurate work, except in special circumstances. Referring to Mr. Deakin's tool-box, he said that, in his opinion, two tools must always be better than one double-cutting tool such as that described. With a double-edged single tool, one side would almost certainly wear quicker than the other. The worn edge would stand higher than the other. Hence, if the depth of cut on each stroke was to be the same, it would become necessary to grind away the sharper edge while it was still in good condition. Mr. Deakin replied that means were provided in the device for adjusting the level of each edge of the tool separately, and without affecting the level of the other cutting position.

The President then intimated that the discussion would have to close, and called upon Mr. Wicksteed to reply.

The author expressed his gratification at the discussion which his paper had elicited, and said that it had taken quite other lines than those he had expected and for which he had prepared his reply. Among other things, he had believed that the subject of the regenerative drive would have attracted attention, but he was very pleased to find that the good old dispute about the practical value of double cutting had been revived. Some years ago he had sold a large quick-return, single-cutting planing machine to a firm of turbine makers. He had, however, taken care that its design was such that it might later on be converted to double cutting. After a few years time the work overtook the capacity of the machine, and he was called in to consult with the firm about it. He advised the conversion prepared for, and, on the idea being adopted, it was found possible to deal with all the work and to dispense with the night shift. In the machine as converted a reversing motor was employed, so that, if required, it could at any time work as a single-cutting, quick-return machine. There was really absolutely no objection to double cutting for plain work. It should be borne in mind that a backward cutting tool always ran more sweetly than one cutting forward. This was emphasised in a four-tool wheel lathe. The tools at the back of the lathe were inverted, the weight of the job acted in the same direction as the force exerted by the tool, and it was customary to find the finishing cuts being made with the back tools and not with those at the front. He did not think it fair to attribute all the lack of interest in double-cutting planing machines to conservatism. It was clear that with double cutting a double feed was necessary. If the feed were not doubled there could be no saving as far as the amount of metal removed in a given time was concerned. There was no advantage in splitting a small feed over two strokes. As regarded the point that had been mentioned by several speakers, the pulling of the saddle off the cross-slide on the return stroke, he would simply say that it was an easy matter to design the machine to be strong enough to take the cut in both directions. He would point out, however, that the cross-slide edges in the best modern machines were not vee-shaped, as represented by the sketches, but square, as shown at A—Fig. 1. In comparing the electric drive with a jockey pulley drive, it was to be noticed that the armature of a motor possessed considerable mass, and if rotating at a good speed represented a fair amount of kinetic energy. On the other hand, a jockey pulley of wood or aluminium would have a mass of only about one-tenth of that of the armature, and therefore only about one-tenth of the kinetic energy at the same speed. The effect of this difference was most noticeable on short strokes—say, those of about a foot. He could endorse Mr. Patchell's remarks about link belts, but it was advantageous to employ them where contra-flexure had to be dealt with.

On the conclusion of Mr. Wicksteed's remarks, the President intimated that, in the absence of Mr. R. G. Aston, the Secretary would read his paper, entitled "Oil-burning Locomotives on the Tehuantepec National Railroad, Mexico." This paper will be reprinted in an early issue of this journal. It is of interest to note that it is the first paper written by a graduate and accepted by the Council for reading before the Institution.

The first speaker, after the Secretary had completed the reading of the paper, was Mr. Mein, of the Great Eastern Railway. Having apologised for Mr. Holden's absence, he dealt briefly with the experience of his company with oil-burning locomotives. By the aid of models and drawings he explained the action of the Holden burner. At this late date it is perhaps unnecessary to describe this well-known appliance. We may say, however, that a jet of steam is blown through an injector-like nozzle and sucks in a supply of oil fuel from one orifice and a supply of air from another. The steam, oil and air jets are then intermixed, and the whole given a spiral movement. The latter effect is secured not by any mechanical appliance, but simply by the action of a secondary steam jet. The orifice through which the air supply is induced can be coupled to the vacuum brake train pipe, so that the burner may assist the action of the ejector. Mr. Mein remarked that when this burner was being tried it was found possible to run about 560 miles without cleaning the fire-grate. Rivet and metal-melting furnaces, stationary boilers, &c., had also been fitted with it, and it was in every way highly satisfactory. The advantages attending the use of oil fuel on locomotives were well recognised. In the first place it had been found that while 8 lb. of water could be evaporated in a locomotive per pound of coal burned, it was possible to obtain 14 lb. of steam from a pound of oil fuel. The wear and tear on the boiler were greatly reduced. The draught required was less than with coal. There was therefore less scarifying action from the blast pipe. The latter could be made with a larger orifice, and this resulted in a reduction of the back pressure in the cylinders. There was an absence of smoke, flame and sparks, a matter of great importance at the present time to railway companies. There was also an economy of labour. The fireman did not require to shovel from 40 lb. to 45 lb. of coal for every mile run. The steam generation was more rapid, storage space was saved, and the weight of the engine could be lessened. But whatever its advantages might be, it was undoubted that its disadvantage in the matter of price barred the adoption of oil fuel for locomotives in this country. In addition to its cost a freight of from 20s. to 21s. per ton had to be paid to bring it from the oil fields to our seaports. To this had to be added the cost of transit from the seaports to the points of consumption within this country. It had been found, therefore, that as a fuel it was, on the whole, more economical to use coal than oil on locomotives in a country with an extensive supply of the former material and far removed from the sources of supply of the latter.

The only other speaker was Mr. F. N. Poignand (Baldwin Locomotive Company), who dealt chiefly with the subject of oil-burning locomotives in the United States. He stated that as a result of taking 2000 locomotives into consideration it had been found that in places where the short ton of coal (2000 lb.) cost more than three times the price of a ton of oil, it payed to use oil as a fuel. Otherwise it did not. In the paper the author had said that the effect of oil burning on the fire-box, flues, stay heads, &c., was not noticeable. On the other hand, it had been found in the United States that the effect was very noticeable. Indeed, stay bolt heads sometimes disappeared entirely by corrosion, and to guard against the stays dropping out when this occurred it was customary to taper the shank of the stay where it passed through the fire-box side plate. He concluded by saying that 2500 deg. Fah. had been found by Professor Gray, of California University, to be the average temperature maintained in the fire-box of an oil-burning locomotive.

The President closed the meeting by intimating that the next would be held on January 19th. Two papers were engaging the Council's attention. One was by Dr. Diesel and dealt with the oil engine associated with his name. The other was by Dr. E. Hopkinson, and was descriptive of the evolution and present position of the turbine pump. It was not yet possible to say which of these papers would be presented at the next meeting.

* The point really is that working in the normal direction a press of 1½ times the load—taking Mr. Hele Shaw's proportions—falls on the front of the lower shear, and only half the load on the back of the upper shear. Cutting in the reverse direction, a pressure of 1½ times the load is tending to lift the saddle off the lower shear, and of one-half the load pressing it on to the upper shear. But the effect on the upper shear may be neglected; the fact that there is an augmented load on the back of the lower shear is the real point. The pull on the upper shear is never as great as that on the lower shear.

LITERATURE.

Principles of Metallurgy. By Charles Herman Fulton. Pages, 6in. by 9in., 544. McGraw-Hill Book Company, New York, London.

This book, more than any other that has come under our notice for some time, emphasises the remarkable change that has come over the character of the knowledge provided for instruction in technological matters. Only a couple or so of decades ago the art of metallurgy still retained much of the mysticism that it had inherited from alchemy. The general environment of metallurgical operations, with its prevailing impenetrable darkness, broken fitfully by the brilliant and lurid flashes from open furnace doors or flowing molten metal, seemed also to pervade its literature. This, in fact, mainly consisted of various incoherent descriptions of processes with no other link to hold them together except that a furnace of some sort played some part in each description. It was Sir William Roberts-Austen's book entitled "An Introduction to the Study of Metallurgy" which provided the student with a logical, substantial, and general foundation upon which to erect a mental metallurgical edifice, in which all the various branches could be gathered together and united in intimate association under one roof, and supported on the same solid basis of identical principles. That volume appeared in 1891, and recently has undergone successful revision at the hands of Mr. F. W. Harbord. The present author, realising, like many others, that the Roberts-Austen classic was no longer up to date, and being unaware of the revised edition, has produced the volume now before us, which follows much on the lines of Roberts-Austen's; but more particularly deals with the physical and chemical phenomena underlying metallurgical matters. These are treated with the precision and thoroughness of a mathematical treatise, and although the permutations and combinations seem to be innumerable and the subject of immense complexity, yet each particular term or combination is allotted a precise mathematical expression or a geometrical position on a curve diagram. It seems strange that this should be the sort of pabulum provided for the students of metallurgy instead of the quaint old stuff that reared successful metallurgists in the past, but perhaps it is good.

The matter is treated in the present volume in fourteen chapters, of which the headings are:—The Metals and Metallurgy from the Historic Point of View; Physical Mixtures and Thermal Analysis; Physical Properties of Metals; Alloys; the Physical Properties of Alloys; the Measurement of High Temperatures; Typical Metallurgical Operations; Slags; Matte, Bullion and Speise; Refractory Material for Furnaces; Fuels; Combustion; Furnaces, the Production and Heating of Blast; An Example illustrating the Physics and Chemistry of a Smelting Operation; The Blast Furnace for Copper. The explanatory portions are well done, but the practical portions do not reach the same level. For instance, in modern coke ovens, and again in gas producers, and again in electric furnaces we notice only one type described and illustrated, and so on. We notice, too, that the plan of blast furnace plant includes a refrigerating plant as an integral portion, which, at least as regards practice in this country, is rather premature. On seeing marked in Fig. 5 *delta* iron, we were alarmed lest the author had thrown a new element of discord into the arena of contentious metallurgy, and were much relieved to find that it is apparently only a misprint. In fact, in the treatment of iron and iron carbon alloys the author skims over thin ice very neatly. It is true, he will not please everybody, but he puts the matter clearly and briefly.

If all this precise knowledge can teach metallurgy it certainly shows that there is no longer any picturesque mystery about the art. Anyway there is no doubt, as the author remarks in the preface, that "metallurgists in general will probably find something of interest in the volume, particularly in the chapters on alloys, measurements of high temperatures, slags and mattes," and to metallurgical students it should prove of great value.

SHORT NOTICES.

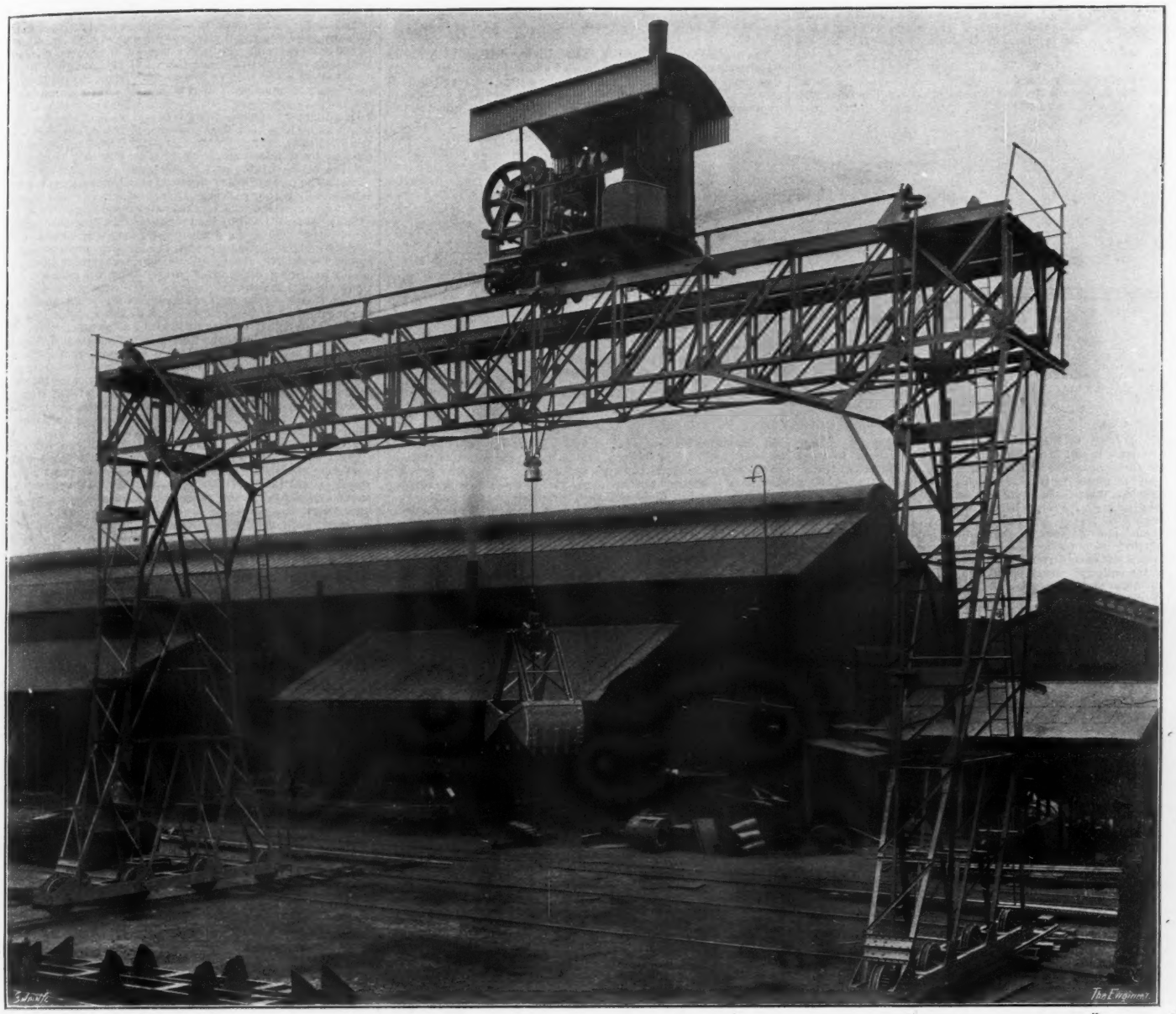
The Practical Design of Reinforced Concrete Beams and Columns. By W. N. Twelvetrees. London: Whittaker and Co., 2, White Hart-street, E.C. Price 6s. net.—The larger part of this book is more in keeping with the intention expressed by the author in his preface of "presenting formulæ, simple working rules, and labour-saving diagrams," than with the title of "The Practical Design of Reinforced Concrete Beams and Columns." One may not agree that 124 formulæ are necessary for the designing of structures of concrete reinforced with steel, but those "engineers and architects" who like to have a formula ready to hand for every conceivable case that may occur in their practice, will find the same in this work, and it would be ungenerous not to appreciate the thoroughness with which the author has faced his task. The number and the increasing complexity of these formulæ as the work advances, will render the labour-saving diagrams given at the end highly acceptable, and these have been ingeniously harnessed in couples to include the rather large number of variables upon which the desired results depend. Of the numerous examples worked out, many can only be regarded as exercises in manipulating the formulæ because the results are not practical. There are many obvious errors in these examples and in other parts of the book which may serve to emphasise the value of the curves provided by the author, for a mistake of any magnitude in results used for plotting these would be so apparent to the eye as to ensure correction. The last two chapters deal with permissible working stresses, materials, and construction.

Pyrometry. By Charles R. Darling. London: E. and F. N. Spon, Limited, 57, Haymarket. Price 5s. net.—This volume, founded on the author's Cantor lectures on "Industrial Pyrometry," is intended to be a practical treatise on the measurement of high temperatures. Mr. Darling's writings on the subject are familiar to our readers, and not a little of the matter in the present work has already appeared in our own columns. The subject is, of course, treated more fully and more coherently in the book than in our articles, and to the increasing number of users of pyrometers the volume should possess great value. There are, as is well known, many ingenious forms of pyrometers on the market. Particulars of most of these will be found in Mr. Darling's book. In addition, fundamental principles are gone into and much valuable criticism, drawn from the author's long experience with such instruments, is given. Although many yet regard pyrometers in general with considerable suspicion and even distrust, still the book fulfils a real purpose. Its value is considerably enhanced in that the author has neglected all instruments and appliances of purely theoretical interest.

The Gasworks Directory and Statistics, 1911-12, and *The Waterworks Directory and Statistics*, 1911. London: Hazell, Watson and Viney, Limited.—These two annuals have again made their appearance, having been revised up to the end of August of this year. They want no word of commendation from us to introduce them to our readers. They are sufficiently well known, and are certainly among the most frequently consulted books of reference in our library.

STEAM GOLIATH CRANE FOR SINGAPORE

STOTHERT AND PITT, LIMITED, BATH, ENGINEERS



5-TON STEAM GOLIATH CRANE.

Recently four steel-framed Goliath cranes have been manufactured by Stothert and Pitt, Limited, of Bath, for Topham, Jones and Railton, Limited, for use in connection with the latter firm's contract at Singapore. As the pier on which they are to work is not substantial enough to carry very heavy weights, the Goliaths had to be specially designed of very light construction throughout and with small wheel pressures. The cranes, which are to be used for grabbing, and to deal with a ¾ cubic yard grab, are designed to be capable of lifting a load of 5 tons at a span of 60ft. centre to centre of ground rails. There is a clear height of 33ft. from the rail level to the underside of the main girders, and a clear width between the legs of 56ft. The following speeds have been employed:—Lifting, 5 tons, 100ft. per minute; traversing, 5 tons, 100ft. per minute; travelling, 5 tons, 150ft. per minute.

The main girders are of the open lattice type, and are constructed of rolled steel sections strongly gusseted and braced together. A light auxiliary girder is provided at one side of the crane, and arranged to carry a platform. This girder is horizontally braced to one main girder for lateral stiffness. The ends of the main girders are held together by strong cross stretchers, and steel rails are riveted to the top of the girders for carrying the crab.

The end frames are built up of rolled steel sections, and are attached to the main girders. Each end frame runs on four double-flanged wheels, having cast iron centres, with steel tires shrunk on. Ladders of access are fitted on either side to enable the driver to reach the platform and crab. The platform just alluded to is made of timber, and is protected by handrails supported by iron stanchions. It is carried on the horizontal bracing between the main and subsidiary girders.

The travelling is operated from the crab by means of a square shaft supported by tumbler bearings and by a train of bevel gearing. Two wheels on each side of the Goliath are driven. The crab has cast iron side frames, fitted with bearings to take the various shafts. It is carried by a built-up steel frame supported on four cast steel double-flanged wheels keyed to mild steel axles, one of which is driven from the engine shaft by means of suitable gearing. The load is lifted on a single part of steel wire rope, 3in. circumference, which is fitted with an overhauling weight and a ball bearing swivel hook. The barrel is of cast iron, and large enough to coil sufficient rope in one lap to allow the hook to descend 70ft. below the rail level. A powerful mechanical brake is provided, which is intended to hold the load in any position. A mechanical brake is also fitted to the travelling gear.

The engines have two steam cylinders 7¾in. diameter by 12in. stroke. The valve rods have a solid forged buckle embracing the slide, the covers being arranged to permit of this construction. The guides are circular, and are bored out in a line with the cylinders. The crank shaft runs in gun-metal bearings fitted with open caps. The feed pump is worked from the right-hand crosshead pin, and the pump has the same stroke as the engine. The boiler is of the vertical type, 4ft. diameter by 8ft. high, and is fitted with two cross tubes in the fire-box. It is constructed entirely of Siemens mild steel, and is designed for a working pressure of 80 lb. per square inch. The coal bunker is made of wrought iron plates neatly finished off with half-round iron. The feed-water tank is placed on the footplate of the crab, so as to allow the water to gravitate into the pump.

The cross-traversing motion is operated from the engine shaft by means of double friction cones, so that the crab may be traversed in either direction without stopping or reversing the engines. A mechanical brake is also provided to this motion. A neat corrugated iron canopy is fitted over the boiler and gear.

We give above a photograph of one of these Goliaths erected in Messrs. Stothert and Pitt's yard at Bath.

In a paper read before the Institute of Operating Engineers some experiments are described which were carried out with a view to finding the effect of restricting the area of tube passage in a boiler 15ft. long by 5ft. diameter, having forty-four tubes of 4in. diameter. The grate area was 25 square feet, and the boiler was rated at 80 horse-power. Preliminary trials gave the average temperature at the back of the boiler, when the gases enter the tube, at 1388 deg. Fah., and at the front, *i.e.*, the smoke-box, at 559 deg. Fah. Tubes of 1¼in. diameter, plugged at the ends with fireclay, were put inside the 4in. tubes, supported at each end by a small tripod casting, so as to remain concentric to the larger tubes, and then the average temperature at the back was 1531 deg. Fah., and at the front 486 deg. Fah. In order to obtain the highest temperature possible at the front end the fire was forced by a fan, and 552 deg. Fah. was registered at the front, 1686 deg. Fah. at the back. The tests with the plugged tubes in position showed a 10 per cent. greater evaporation per pound of coal. The fuel used was buckwheat, and no trouble was experienced in keeping the tubes clean. Plotted diagrams of the temperature readings are given.

CONTINUOUS SERVICE PASSENGER TRANSPORT.

At the last meeting of the British Association, Mr. Yorath Lewis read a rather hurriedly prepared paper on a screw railway. On Wednesday evening, 13th inst., he went into the subject more carefully at the Society of Arts. A good deal of his paper was concerned with the broad principles of passenger transportation in large cities—London in particular being considered—and several very ingenious diagrams were exhibited on the screen. Still more of the paper was devoted to the benefits which would accrue from the use of a system like the Adkins-Lewis, which is absolutely continuous, which never stops, is placed in a shallow subway, and which provides that a "train" shall always be in the station, so that there is never any waiting. Broadly the system is this:—Throughout the length of the line and between the rails there extends a screw driven at a constant speed by electric motors. Under each coach is a roller arrangement which gears with the thread of the screw. This thread is not of constant pitch. It is very close in the stations, and gradually opens out in the intervening length. Thus the speed is very low at the stations—say, two and a half to three miles per hour, and gradually increases to, say, 25 miles per hour, again falling off to two and a-half to three miles per hour as the next station is approached. The coaches consist of light vehicles, seating only a few people, and entirely open in front. The passengers board and leave them whilst they are in slow motion through the stations. The coaches are so disposed on the track that they are always packed close together at the stations and in open order in the intervals. Thus some coaches are always to be found awaiting passengers. The acceleration is so gradual that no inconvenience is suffered by its rapidity, and Captain Sankey stated on Wednesday that he had stood upright in a compartment on the experimental track at Ransome and Rapier's works and had not experienced any of the tendency to fall over which is felt in ordinary electric trains.

It will be seen that the screw system meets the requirements almost ideally. The question for engineers is: "Are the mechanical details sound?" and we turn, therefore, to the description of the railway as given by

Mr. Lewis. We may say that slides from a number of working drawings were shown on the screen, but for the present the inventors do not wish to publish them. The drawings we give are therefore more or less diagrammatic.

Referring to Fig. 1, diagrammatically representing the arrangement, it will be seen that the driving means employed comprise a spiral threaded shaft L, which is rotated at a constant speed. Engaging with the spiral thread 2 are rollers E R and R R mounted with spring connection B to the under side of the leading truck A. The running wheels are flangeless and roll along the tracks S—Fig. 2. The leading and trailing trucks are designated respectively A and C. Upon these trucks is mounted the car body 6, through the medium of springs S. The trucks are also provided with guide rollers T R, rigidly fixed thereto, and

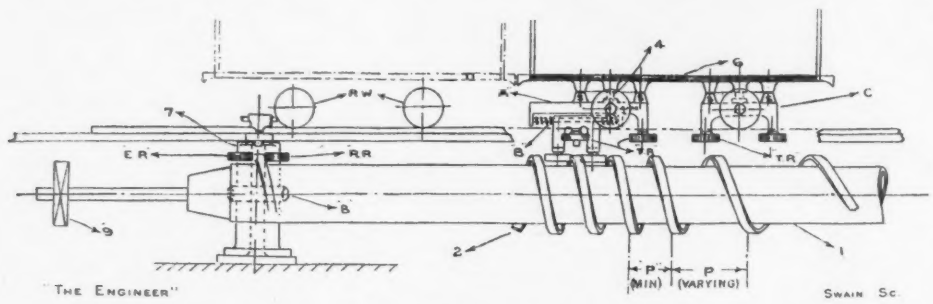


Fig. 1

located centrally between the running tracks—Fig. 2. These guide rollers T R run in a chase forming side tracks 3, to resist the side thrust occasioned by the angularity of the spiral thread drive, and to guide the trucks—which swivel under the car body 6 about the pins 4—*en route* and around the ends Z—Fig. 4. Here the reverser 7, driven by the worm and wheel S, suitably connected with the driving shafts by means of gearing 9, meshes with the projecting shank of the leading guide roller T R before the engaging roller reaches the last thread convolution of the shaft by which it has been driven. The reverser 7 thus takes the car around the ends and serves to put the E R into correct engagement with the first convolution of the thread upon the other shaft for the return journey. The driving shafts are carried at suitable intervals upon cradle rollers C R—Fig. 2—forming bearings of the well-known "anti-friction" type. At the places where these cradle rollers are located, a muff or boss—Fig. 5—is mounted. This muff or boss is slightly larger than the outside diameter of the screw thread, and is provided with a spiral groove 11 on either side of the thread 2, so as to permit the passage of the engaging and retarding rollers E R and R R. The length of the muff or boss, and of the cradle rollers C R is proportioned to be sufficient to ensure an adequate bearing.

As the driving shafts are rotated at constant speed, it follows that the speed imparted to the cars engaging therewith will be proportional to the pitch of the thread. For traversing stations the pitch and thread angle is low—approximately 8 deg.—and provides a uniform slow speed. But in order to provide a high speed *en route* between stations, the pitch and angularity is steep—namely 45 deg., or even as much as 53 deg. The change from low to high pitch, and *vice versâ*, to provide acceleration and deceleration, is gradually increased or decreased, as the case may be. Herein lies the outstanding feature of the system, and this is further dealt with in connection with efficiency, return of energy to line, and acceleration, later on in this paper, but more particularly in the author's British Association paper.

The cars are always engaged on an equal number of threads apart, irrespective of the pitch; the number of minimum pitch threads being so selected as practically to equal the overall length of one car. The obvious result of this is that peculiar advantages are secured, viz., that the cars congregate in close formation at the stations, and that they space out to considerable distance apart when at high speed *en route* between the stations, so that, compared with any system of uniform speed platform, it is clear that very much less rolling stock is required by this system. The close formation of the cars at the stations permits convenient means for introducing adequate provision for applying the motive power to the driving shaft, and also taking care of the end thrust*

* The end thrust is not of serious amount, since the reaction due to accelerating cars is largely counterbalanced by decelerating cars.

due to the reaction of the cars, propelled by the spirally threaded driving shafts. Referring to Fig. 6 it will be seen that if the overall length of the cars is made practically equal to the number of minimum pitches between adjacent engagements, the cars will just touch each other. Obviously then a gap in the spiral can be made at the close pitch section, and this gap provides for the reception of the driving motor 12 and the bearing 14, with which is incorporated the thrust ring 15—Fig. 3. Clearly the cars will be pushed over the gap by those following, thus ensuring correct engagement with the recommencing thread on the other side thereof.

The motive power is applied to the driving shaft on both routes simultaneously by the introduction of gearing 13 cross-connecting them, and taking the motor drive at the centre between tracks as shown. Similarly, as will be shown later, curves and changes of grade can be negotiated by introducing bevel gears which enable any length of driving shaft to be set at any angle with the adjacent length. In this case also advantage is taken of the gap in the thread to insert bearings and thrusts. Since the cars are absolutely controlled and regulated automatically by the engaging rollers E R and R R respectively, operating on the leading and trailing sides of the thread 2, and coming into action respectively at periods of acceleration and deceleration, there is no necessity of any braking and signalling system, such as are all-essential with the train system. Furthermore, there is no necessity to employ drivers and train conductors, nor for the numerous skilled and unskilled attendants connected with the train system at substations and power-house.

The length of the station needs to be only 50ft., or at most 75ft. A car moving at 3 miles per hour would take 17 secs. to pass through. Thus there would be 8 secs. for passengers to step out of the cars during the passage of the first half of the station, and 9 secs. for other passengers to step in during the passage through the other half of the platform. As a matter of fact, it does not require a second of time for even a slow-moving person to step over a line.

But now let us see how such a traffic flow as that of the District Railway would be handled on the Adkins-Lewis system. There would be two streams, one going on through one half-length of the station and the other coming off using the other half-length of station. Each being of 4500 passengers per hour would mean streams of 75 passengers per minute. If the walking speed be the usual 3 miles per hour, we should have each stream a single file of passengers each over a yard apart, or two abreast 2½ yds. apart. The "on-coming" stream would always be under check at the turnstile entrances to the station at street level, and would be controlled by the collector, who would regulate the flow according to the capacity available. The "off-coming" stream would have amply spacious exits and platform space. Now taking the carrying capacity of the equipment at 9900 seats per hour, passing any point, plus 60 per cent. standing room, which may here be neglected. Thus, if there were 4500 passengers riding through per hour, and 4500 passengers getting both on and off at each station per hour, there would still be 900 empty seats per hour passing through each station, or 5400 seats available for the 4500 passengers getting on. Designating the broad double opening in the side of each car as one "entrance," there would be available for each of the 4500 "on-coming" passengers four entrance seconds, or one entrance for 4 secs. Each passenger would have a choice of four cars extending for about 12 yds. along the platform. Similarly each "off-going" passenger would have one double exit for 4 secs. Thus, even this heavy flow, which we found could not be negotiated by the District Railway, even with 50 per cent. more capacious service, could be handled quite conveniently by the "A and L" system. Of course it is far greater than would be usual in the case of a route having four stations per mile. For the conditions when the traffic flow would be either all "on-coming" or "off-coming," the entire length of the station could be utilised, and at terminal stations, of course, the length and width of the stations would be suitably proportioned.

The point that the author wishes to emphasise is that by handling the passengers in streams instead of in congregations much greater capacity and comfort can be secured, and that accompanying these advantages are others even more important.

Although smaller capacity would probably be found sufficient in many cases, let us consider the detailed designs for capacity of 12,680 seats per hour with initial speed of three miles per hour, or 8500 seats per hour with initial speed of two miles per hour. In each case the overload is 50 per cent. standing capacity. The complete two-track equipment with side walks requires only 17ft. width in the clear, and 13ft. depth. A 16ft. diameter, or at most a 17ft. diameter, tube would be sufficient for runs between stations, which would have 10ft. wide platforms. The cars are eight-seated, their bodies being readily removable from the trucks, which are coupled by a yoke permitting each to take any curves by the guiding action of the thrust rollers travelling in the central chase. The forward truck carries the double-engaging rollers very substantially; the running wheels, which are flangeless, are retained on their tracks by the central guide and thrust rollers. Derailment is obviated by the provision of a tilting check operating against the edge of the guide tracks. Here it should be stated that the slightest derangement causing this check to come into action would close electric circuits, which would cut off the power supply to driving motors and quickly bring the system to a stop. One form of automatic gate is shown at the car entrances. It will be seen from the plan and elevations that this is operated, through the medium of a spring to prevent pinching, by a very simple arrangement actuated by contact with a side track.

It is proposed to build the tube of hexagonal form with standard rolled steel trough sections. It will be seen that distance pieces are inserted between the sections, and the whole is heavily riveted together. One end of these distance pieces is extended to carry and secure the spiral, and where the spiral pitch is close, three such fastenings per convolution, whilst six per convolution where the pitch is spread out, are found to be amply sufficient. The shafts are built up in lengths of 44ft., and the joints are triple-scarfed, bolted up by heavy turned bolts fitting drilled holes slightly oval to permit of expansion and contraction. In this connection it should be remembered that, as the temperature of subways does not vary more than 10 deg. to 15 deg. all the year round, the amount of expansion and contraction is extremely small, and can be satisfactorily provided for in the manner shown. The spiral consists of a stout rail or bar-section of more than ample strength. It is easily made to great accuracy by simply winding on a mandril in convenient lengths, which are fish-jointed together after mounting. The diameter of the shafts for the speeds required is 24in., when the spiral pitches vary from 12in. to 96in. Thus at 264 revolutions per minute constant shaft speed, linear speeds of three and twenty-four miles per hour are given. The weight of the shafting complete, with bearing sleeves located about every 44ft., carried in cradle roller bearings as shown, is about 110 lb. per foot run. The cost per ton is obviously very moderate, as also is that for the entire equipment, including erection, seeing that all parts are light and portable, and largely repetition work.

We may now consider how a sharp curve of about 70ft. radius is negotiated. It has already been explained that where the spiral pitch is close the cars congregate together, and, if necessary, can be made actually to touch each other. Obviously, then, the spirals can be eliminated. The car engaged with the last few close pitch spirals on the one shaft will push the cars ahead of it over the gap and into correct engagement with the first spiral convolution on the next length of shafting. It does not matter if the gap comprises a straight run or a curve. The force necessary to push even a considerable number of cars around such a curve is a mere bagatelle, the speed being low and the track level. Although quite possible, the negotiation of curves at high-speed sections is unnecessary, because wherever a curve is necessary it would not be inconvenient to locate a station. Advantage is taken at such points to introduce the driving motors, *i.e.*, at stations every quarter of a mile along the route—the shafts being enormously over-strong to transmit the power required without appreciable distortion.

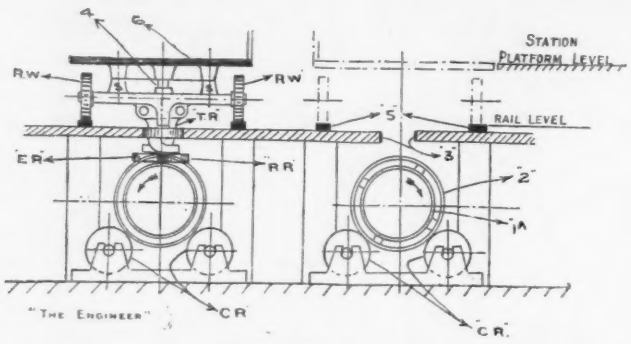


Fig. 2

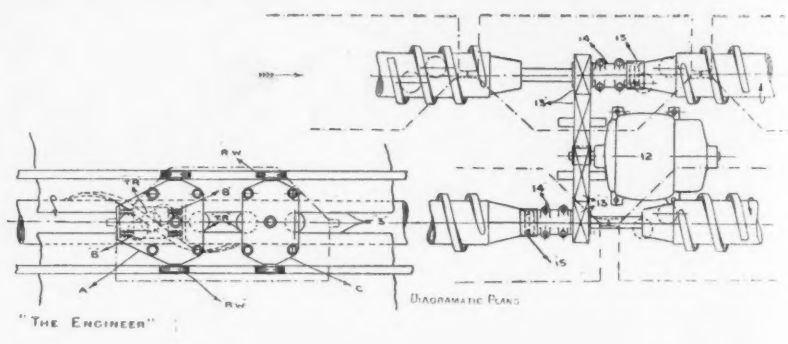


Fig. 3

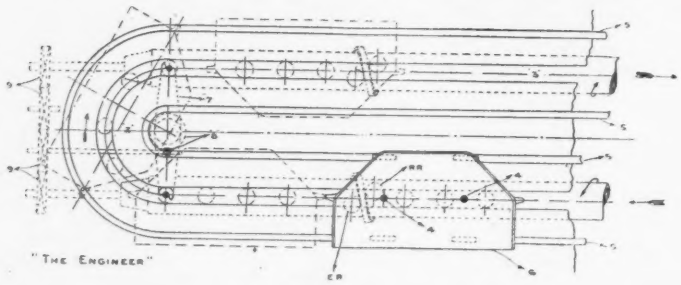


Fig. 4

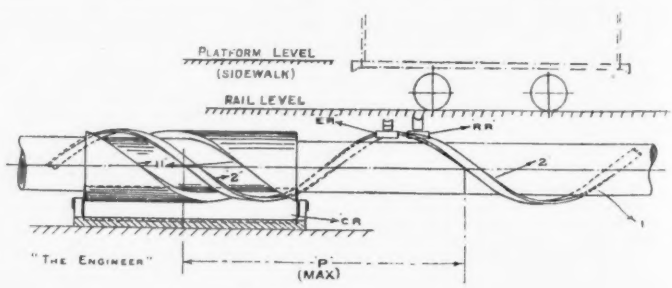


Fig. 5

After touching upon the methods of making joints at changes of grade, the author went on:—

As regards the power consumption, a quite simple calculation upon data very conservatively applied against the system when operated at a capacity of 12,672 fully loaded seats per hour, at a schedule speed of 16 miles per hour, on a route having four stations per mile, shows that only 200 kilowatts input per mile of track is sufficient to cover the total consumption for lighting, car propulsion, shaft rotation, and thrust, and all losses, including the motors. Thus the energy per seat mile would not exceed 15 watt-hours in ordinary practice. This is only about one-third of the amount found to be necessary in train practice, when there are

but half as many stations per mile. Bearing in mind the uniform nature of the load, and the consequent lower cost of power per unit, especially if Diesel engines be used in its generation, the relatively greater amount of power consumed in brilliantly lighting the route throughout as proposed does not vitiate the claim that, compared with electric trains, the Adkins-Lewis system can provide an equivalent service for less than a quarter of the power consumption per seat mile, neglecting lift and other incidentals to tube railways altogether.

It is difficult to generalise in the matter of both capital and operating costs, but carefully prepared estimates indicate that the capitalisation ought not to exceed one-half that of the more recent tube railways. As regards gross operating expenses, the figure of 0.04d. per seat mile appears to be well on the safe side.

It only remains to consider the question of wear and tear, the safety factor in component parts of the equipment, its general behaviour when at work, and lastly, the feasibility of the continuous plan for public service.

First, then as to wear and tear. Take the cars. Their deadweight is about 350 lb. per seat; therefore, there is only about one-third the amount of rolling-stock subject to depreciation that there is in the train system for equivalent schedule speeds and capacity. The car bodies are relatively quite as strong, but there is less vibration, and the stress coming upon them is decidedly less severe. Their trucks carry no complicated electrical equipment, nor is there the usual noisy air compressor for the brake system, because no brakes are required. Thus the running wheels, which are flangeless and carry but light loads, will have a long life and will run easily. The whole car, including the automatic gate or door operating arrangement, is of the simplest possible character, substantial in construction, and with low centre of gravity—all tending to endurance and low initial and maintenance cost.

Now as to the tracks. The rolling loads are so light and well distributed that the usual heavy rails can be substituted by either a light steel bar section, or fibre or even rubber, set upon longitudinal timbers, thus securing comparative noiselessness. The central guide and thrust tracks are subject to practically insignificant loads, so that these parts do not appear likely to give any trouble.

Now we come to the wear and tear of the edges of the spiral and its pair of engaging rollers. Here it may be pointed out that the proper working of the engagement is not affected by slackness to almost any extent between the thread and its engaging rollers, and that there can be an ample margin of stock in the width of the spiral bar to cover any amount of wear that is likely to take place in many years. Consider the pressures that the spiral exerts against its engaging rollers, and *vice versâ*; for the leading roller alone is engaged during the propulsion and the trailing roller only during retardation. The pressures are extremely small. Assuming

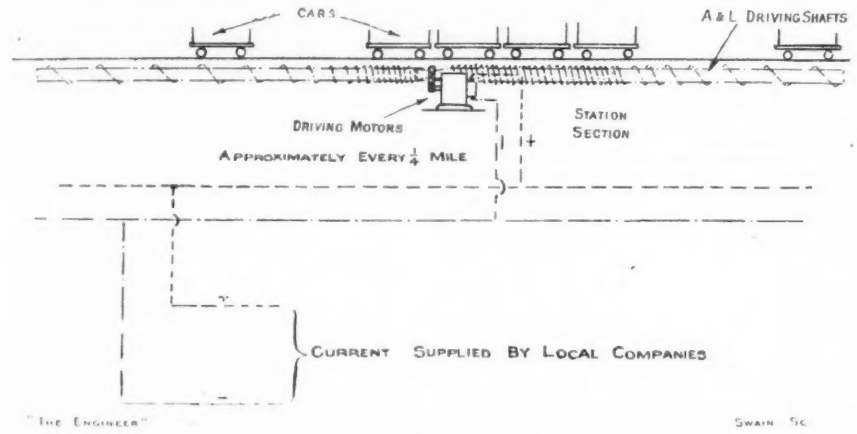


Fig. 6

the cars weigh two tons fully loaded, and that the tractive effort is assumed at the high value of 10 lb. per ton on the level, it will be seen that for uniform speed sections, constituting about 70 per cent. of the track length, the pressure is only about 20 lb., whilst for the remaining 30 per cent., comprising the acceleration and deceleration sections, this pressure is gradually increased and decreased in the case of level tracks to a maximum of possibly 1000 lb. Even this is not serious, and would be greatly minimised by the use of grades as previously indicated. Of course, an entire route may be graded all the way, but the pressures would still be low.

In the consideration of these various points relating to wear and tear, it should be borne in mind that all the component parts are repetitions of but a few standards, and that naturally they would be made to gauge. All parts are readily "get-at able." Even a length of shafting could be removed and replaced within a couple of hours, and there would be six hours every night and a longer period on Sundays for inspection and rectification, lubrication and cleaning.

The second item remaining to be dealt with is that of the safety factor. In this respect the system, as a whole, lends itself remarkably well in every detail to the provision of exceptionally high factors of safety without detriment in other directions. The chances of breakages of any parts are extremely remote, possibly more remote than is usual in railway practice. Yet flaws in metal parts are recognised to be possible—indeed, even inevitable. Then let us suppose that the obviously most vital part, viz., an engaging roller spindle, gave out. What would happen? It could drop on to the shaft, and then be very promptly thrown away to the side by centrifugal force, without doing damage, whilst the car would still be controlled by one roller. The free play it would have would only be 8ft. at maximum pitch, so that no serious consequences would result. Such a breakage could be as safely guarded against as a broken axle on a railway train, and remember that electrical means could be provided to indicate the slightest derangement of any part. Perfection is not claimed for the system, nor are the designs shown in this paper either final or even the latest.

The third point relates to the behaviour of the system in working order. Of course this, as well as the two preceding points, can only be determined by actual trials upon a full-size equipment, but as regards the question of noise, it may reasonably be expected that, with "Citroen" gears, the cradle roller bearings suitably mounted, and other precautionary measures, noise will be practically eliminated. Anyhow, it will be far less than prevails in trains and trams. The riding of the cars will undoubtedly be far more free from vibration and swaying than in those cases. Ventilation and other considerations also can obviously be dealt with in satisfactory manner.

There was only a brief discussion on the paper, a notable feature in it being Captain Campbell Swinton's remarks on the difficulty of cutting shallow subways in London.

DOCKYARD NOTES.

DEVONPORT'S new battleship will, it is stated, be officially laid down on New Year's Day. Work on the slip and in getting materials together has been going on for some time.

THE average speed made by the German battle cruiser, Moltke, on her trial is now stated to have been 28.1 knots.

ONE of the two new Turkish battleships has just been laid down at Barrow. She will be of a displacement of 23,000 tons, armament ten 14in. guns, speed 21 knots.

NEXT February has been selected for the launch of the second Austrian Dreadnought of the Viribus Unitis class. She is intended to be ready for service in 1913. Dreadnought III. has not yet been laid down, but it is expected that she, together with the fourth Dreadnought, to be built at Fiume, will be laid down next January, as both ships have to be completed by 1914.

THE Hawke has now completed her repairs and been fitted with a straight stem instead of her old ram type bow.

RUMOUR has been busy about the new Japanese ships reported to have been laid down some while since. The latest report is that they will be laid down shortly, but very little work has been done on them for some time, economy being the order of the day just now in Japan.

THE latest Portuguese programme is three armoured ships of 20,000 tons each, three scouts of 35,000 tons, twelve destroyers of 820 tons, and six submarines of 360 tons. Three wireless stations are also to be erected, and the estimated cost is £8,800,000.

THE French cruiser Waldeck Rousseau has just finished her trials, and in the ten hours' trials with all boilers, developed a mean of 36,110 horse-power. The speed has not been stated beyond that it exceeded 23 knots.

THE target practice results of the French fleet are as follows:—The Gloire, which fired under different conditions, making 20.2 per cent.; Justice, 20.56; Gaulois, 18.14; Charlemagne, 15.6; Democratie, 14.8; Jauréguiberry, 14.6; Saint-Louis, 13.75; Marseillaise, 13.1; Vérité, 12.42; Amiral-Aube, 11.5; Ernest-Renan, 11.42; Suffren, 11.19; Patrie, 10.76; Léon-Gambetta, 8.89; Edgar-Quinet, 7.9; Liberté, 7.89; Charles-Martel, 7.30; Carnot, 6.80.

WE hear that the Italian Government has decided to adopt the Yarrow boiler, and that two of the latest battleships are to be fitted with these generators. Each vessel will have twenty boilers. They will be designed at Scotstoun, and the drums and water collectors will be made there, but the erection and completion will be effected at Genoa by Ansaldo-Armstrong, who have the contract for the machinery.

TRIALS OF THE FRENCH BATTLESHIP VERGNIAUD.

THE French battleship Vergniaud forms one of the Danton class, and she has recently completed her official trials to the satisfaction, so we understand, of the French Admiralty. There are six vessels in this class, namely, the Danton, Mirabeau, Diderot, Condorcet, Voltaire, and Vergniaud. Their normal designed displacement is 18,400 tons, their length over all 480ft., their length on the waterline 475ft. 9in., their beam 84ft. 9in., and their maximum draught 27ft. 6in. They carry four 12in. guns and twelve 9.4in. guns. They are fitted either with Belleville or Niclausse boilers, three having one type and three the other. The Vergniaud is the last of her class to be added to the French navy. We have dealt from time to time with the performances on trial of her sister vessels. The Vergniaud was built at the Gironde Works, engined by the Mediterranean Works, and fitted with Niclausse boilers. The engines are two sets of Parsons turbines driving four shafts. We give below the official figures obtained on the trials:—

Ten Hours' Full Speed Trial.

Date	31st Oct., 1911
Number of revolutions per minute, mean	285.57
Average speed	19.15 knots
Coal consumption per mile run	2116 lb.
,, ,, hour	18.09 tons
,, ,, square metre of grate	127.80 kilos.
,, ,, square foot of grate	26.17 lb.
Steam pressure at boilers	239 lb.
,, ,, steam chest	109 lb. to 121 lb.
Vacuum at condensers	667 mm.

Three Hours' Full Speed Trial with Forced Draught.

Date	16th Nov., 1911
Number of revolutions per minute, mean	302.96
Average speed	19.675 knots
Coal consumption per mile run	1.17 tons
,, ,, hour	23.0198 tons
,, ,, square metre of grate	161.94 kilos.
,, ,, square foot of grate	33.17 lb.
Steam pressure at boilers	249 lb.
,, ,, turbines	153.25 to 155.73
Vacuum at condensers	561 to 634 mm.

Twenty-four hours' Consumption Trial.

Date	11th Nov., 1911
No. of revolutions per minute, mean	261.2
Average speed	17.74 knots
Coal consumption per mile	1516 lb.
,, ,, hour	12,006 tons
,, ,, square metre of grate	84.72 kilos.
,, ,, square foot of grate	17.35 lb.
Steam pressure at boilers	223.2 lb.
,, turbines	172.0 lb.
Vacuum at condensers	692 mm.

Consumption Trial with Half Boilers at Work.

Date	7th Nov., 1911
No. of revolutions per minute, mean	182.35
Average speed	13.38 knots
Coal consumption per mile	959 lb.
,, ,, hour	5.73 tons
,, ,, square metre of grate	80.56 kilos.
,, ,, square foot of grate	16.67 lb.
Steam pressure at boilers	216 lb.
,, turbines	67.8 lb.
Vacuum at condensers	615 mm.

Slow-speed Consumption Trial.

Date	
No. of boilers at work	7.0
,, revolutions per minute, mean	119.7
Average speed	8.57 knots
Coal consumption per mile	710 lb.
,, ,, hour	2.72 tons
,, ,, square metre of grate	71.25 kilos.
,, ,, square foot of grate	14.6 lb.
Steam pressure at boilers	228.24 lb.
,, turbines	22.74 lb.
Vacuum at condensers	610 mm.

The designed speed of these vessels is 19.25 knots.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE MECHANICAL PRODUCTION OF RUST.

SIR,—I noticed your remarks on my letter referring to the above subject. You will find, on reading my arguments carefully, that they cover all the possible ground, except the thermal effects. It is, however, hardly to be expected that I should touch the most dangerous objection to the electrolytic theory; hence, I leave this point to others. With regard to pendulum springs, I quite agree that they stand a very long time indeed. If my memory serves me correctly, one of the clocks at Upsala Observatory has been kept going perpetually for nearly a century. We must not forget, however, that the period of the movement is very slow, and that the shock is nil, as gravity brings the pendulum back, not the spring action. Whether such an action can be compared with the case under discussion is doubtful. With regard to pieces being turned in a lathe, I think that cases of rusting in the chuck have been observed. A regular occurrence of mechanical rusting is the following:—Mixing rolls running together at different speeds rust at once if run "dry," and they rust badly. Wetting the rolls with spirits prevents the action completely. I am indebted to my friend, Mr. A. C. Hyde, of the Vactite Company, for this information, but I have often observed the quick rusting of cold rolls myself. A necessary condition seems to be that the temperature must coincide with the liquid phase of water. Spraying water on the rolls greatly assists the action. I do not think that I am giving away a secret by relating that the best way of grinding rolls true consists in running them together whilst water runs over them. The protruding parts rust, and not the hollows. Were it otherwise, the process would not work. As it is, it works well and incredibly rapidly. My familiarity with this phenomenon made me forget it when writing my first letter. Perhaps some other reader may have made similar observations.

December 12th. JOHN RHODIN.

THE ADHESION OF FLAT SURFACES.

SIR,—Referring to your article on Mr. Budgett's experiments on the adhesion of glass plates (page 570 *ante*), may I point out that the subject was investigated many years ago, though in a manner somewhat different to that employed by Mr. Budgett. There is a section at page 118 of Professor Moseley's "Illustrations of Mechanics" (sixth edition, 1859) dealing with the adhesion of plates of different substances to the surfaces of fluids. Quoting some experiments by Gay Lussac, he shows that the force necessary to detach a plate of glass from the surfaces of water, alcohol and turpentine, respectively, varies in about the same proportion as that found necessary by Mr. Budgett to separate two pieces of glass having a film of the above liquids interposed. Achard, whose experiments are said to have been published in the "Berlin Memoirs" for 1776, found that variations of atmospheric pressure had no perceptible effect, but that a rise in temperature decreased the adhesion. Professor Moseley also refers to experiments made by Guyton de Morveau, and published in his "Eléments de Chymie (1777), on the adhesion of plates of various metals to the surface of mercury. I am unable to give the exact references to the two papers quoted above, but they may easily be found by those who care to pursue the subject, by the aid of the Royal Society's "Collection of Scientific Papers," or of Boggendorf's "Biographisch-Literarisches Handwörterbuch."

Perhaps I ought to say that in writing this letter I have no desire whatever to detract from the value and interest of Mr. Budgett's researches. R. B. PROSSER.

PROPELLERS FOR FLYING MACHINES.

SIR,—I judge from your correspondent "A. R.'s" letter in the October 13th issue that we are at cross purposes in this matter.

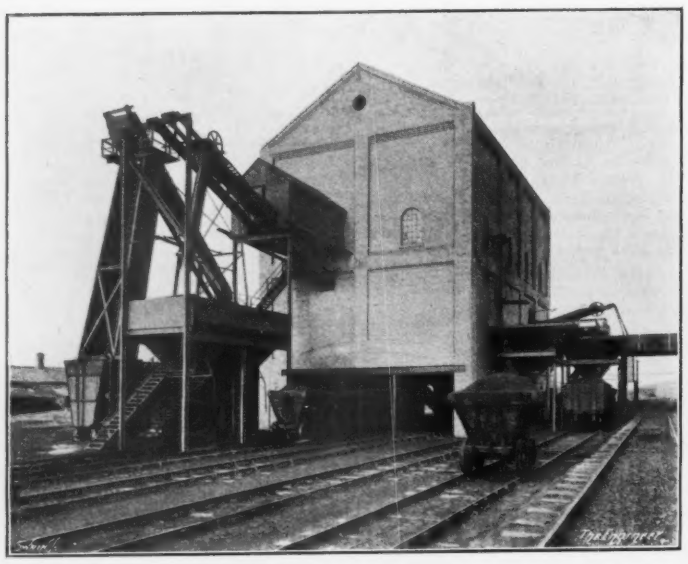
There is, of course, no contention possible as to Newton's laws. The real point at issue is the sectional area of the departing stream. Rankine's rule assumes that this is equal to "pitch-circle" behind the propeller. Furthermore, it assumes that the mean velocity of this departing stream is equal to the so-called "propeller velocity" (pitch and revolutions). My point was that the area of the approaching stream when the velocity of translation is considerable cannot greatly exceed the pitch-circle area, and therefore the area of the departing stream is smaller (*i.e.*, the stream contracts). As to the velocity, in the course of the article I pointed out that it cannot exceed the relative velocity of the air to the blades, of which the axial component is not necessarily as much as the "propeller velocity."

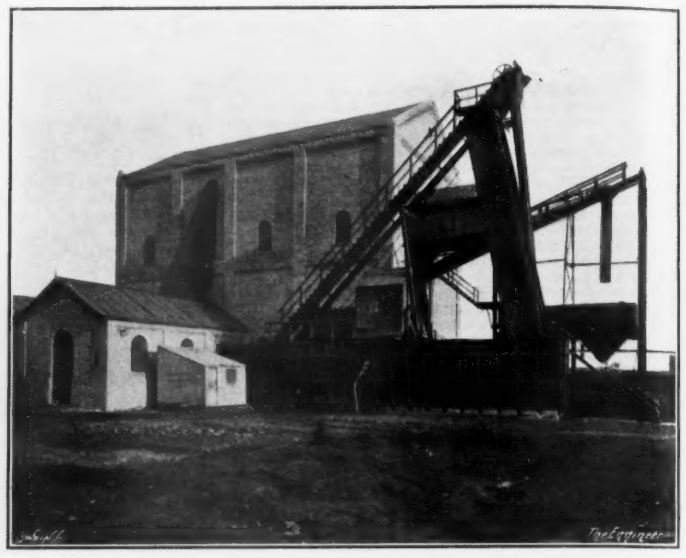
It should be clearly understood that I suggest the new form as only applicable to propellers with a considerable velocity of translation. At low speeds, when the feed is free in all directions, Rankine's rule is probably nearer the facts, and I have not suggested otherwise. HERBERT CHATLEY.

Tangshan, North China, November 22nd.

COAL WASHERY AT THE CRAMLINGTON COLLIERY

CAMPBELL, BINNIE, REID AND CO., HAMILTON, N.B., ENGINEERS





COAL-WASHING PLANT AT THE CRAMLINGTON COLLIERY.

ONE of the most important groups of collieries in Northumberland is that of the Cramlington Coal Company, Limited, of Newcastle-upon-Tyne, which works the Shankhouse (Amelia Pit), Hartford (Scott and Daisy Pits), Cramlington East (Lamb Pit), Cramlington (Betsy and Ann Pits), Cramlington West (Wrightson Pit), and Dudley. At East Cramlington, which is in the centre of this group of collieries, a coal-washing plant of an interesting design, manufactured and erected by Campbell, Binnie, Reid and Co., of Hamilton, N.B., has quite recently been put into operation. The unwashed coal is brought from all of the Cramlington collieries in hopper-bottomed wagons, and, on arrival at the washery, the contents are emptied into a receptacle arranged under the rail level. This receptacle has a capacity of about 40 tons for the purpose of overcoming any intermittency due to delay or irregularity in the emptying of the wagons, and providing a more regular supply of unwashed coal to the washer. The bottom of the receptacle is hopper-shaped, so that it automatically empties itself into a bucket elevator which elevates the coal into the washing plant. The bucket elevator is constructed of steel throughout, the buckets being totally enclosed in a mild steel casing. The buckets are attached to two pitch chains formed of mild steel, single and double links alternately, special arrangements being made to minimise wear.

The coal is delivered from the elevator into a set of jigging screens, 6ft. wide. These are of the usual type, and by means of them the coal is classified into suitable sizes for washing, and is delivered into the makers' improved bash and felspar washers. All coal which passes over a ½in. mesh passes to the bash tanks, and all coal which passes through a ½in. mesh to the felspar tank.

The bash washers, of which six have been installed, are constructed of cast iron plates, bolted together to form a water-tight tank. Particular care has been taken by the makers to render the action of these washers as automatic as possible, the only supervision required, after the valves have been set to suit the quality of coal to be washed, beyond the usual attention given to oiling, &c., being for an attendant to operate the sludge doors two or three times in an hour. The excentrics operating the plungers are adjustable, so that the stroke can be altered from 0 to 4½in. The bearing surfaces are kept lubricated by a self-oiling device.

The washed coal from the bash tanks is delivered with the overflow of water into a second set of jigging screens, where the water and any peas and "gum"—the finest coal or sludge—which may be contained in it are drained off, and the nut coal is classified into the market sizes, three sizes of coal being made—viz., trebles, doubles, and singles. The trebles are delivered direct by means of a shoot into wagons, and the remaining sizes are delivered into separate bunkers, each of 15 tons capacity.

Eighteen of the makers' latest design of felspar tank have been fitted up for washing the peas and sludge. These are arranged in three nests of six each, and are formed of cast iron plates, bolted together. The excentrics are of the adjustable type. The meshes carrying the felspar bed are bolted to cast iron frames, arranged so that repairs may be easily carried out. The action of these tanks is entirely automatic, the unwashed coal and the washing water entering at one end of the nest, travelling over three beds of felspar, during which the stone or other foreign material of a specific gravity greater than that of the coal is separated from the coal and passes through the felspar beds, while the clean coal and water pass out at the extreme end of the nest. The agitation of the water in each bed is graduated by means of the adjustable excentrics, and is greater at the entering end than at the leaving end.

The washed coal from the felspar tanks is delivered along with the overflow water into a recovery apparatus, consisting of a conveyor of the scraper type, having a perforated bottom, which separates the water and fine gum from the peas, the former passing through the perforations and being delivered into pipes to the fine gum recovery plant, and the peas being conveyed to the delivery end of the conveyor and delivered into a bunker over the wagon road. The fine gum or sludge recovery plant consists of a dredging elevator working in a cast iron tank 60ft. long by 11ft. deep, the elevator travelling at a slow speed, and being fitted with perforated buckets, so that the water is afforded time to drain off. The recovered gum is delivered by means of a shoot into a bunker placed over the wagon road.

The water required for working is circulated through the machine by means of one of the Pulsometer Company's centrifugal pumps driven by belting from the main motor. The washed nuts and peas are cleansed by a fresh water spray supplied with fresh water by a force pump belt driven from the main motor. The refuse from the bash and felspar tanks is collected and led by means of pipes into the casing of an elevator conveyor of the bent link scraper type, and is enclosed in a water-tight casing which extends above the level of the water in the bash and felspar tanks, the conveyor itself being extended upwards so that the water may have time to drain off. The refuse is delivered into a bunker over the wagon road.

The main plant is driven by one of Ernest Scott and Mountain's 200 brake horse-power three-phase slip ring motors working at 2750 volts and 350 revolutions per minute, and the fine coal recovery plant and the refuse conveyors are driven by two 12 brake horse-power motors manufactured by J. and H. Holmes, Limited.

A special feature of this installation is that by the arrangement of the main machinery on one level the attendants have all the most important of the working parts constantly under their immediate supervision. Repairs can be effected under the most favourable conditions, as ample room has been allowed, and the machinery is easily accessible. The effect of the washing is to convert all classes of the coal treated from a comparatively inferior fuel into a clean high-class steam coal having all the qualities of a high-class Northumbrian steam coal, and of a size the most suitable and efficient for modern boiler-firing appliances and gas producers. The main structure was erected by the Cramlington Coal Company, Limited, and is of a substantial character throughout, the outer walls being of brick and cement, with steel roof, and the machinery is carried by heavy steel girders. We give two views of the building on this page, and sectional drawings are given in our two-page Supplement.

FORTHCOMING ENGAGEMENTS.

THURSDAY, DECEMBER 28TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture I., "Introductory," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

FRIDAY, DECEMBER 29TH.

JUNIOR INSTITUTION OF ENGINEERS.—Visit the Factory of Messrs. Otto Monsted, Limited, Margarine Manufacturers, at Southall. The party will leave Paddington Station by the 2.23 p.m. train, arriving at Southall at 2.56 p.m.

SATURDAY, DECEMBER 30TH.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. Social Evening for the Junior Section. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Boiler Shop Design," Mr. W. J. Bennett. 6.45 p.m.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture II., "The Duration of Youth," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

TUESDAY, JANUARY 2ND.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture III., "Colours and Patterns of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

THURSDAY, JANUARY 4TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture IV., "Young Animals at Home," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

FRIDAY, JANUARY 5TH.

JUNIOR INSTITUTION OF ENGINEERS.—The Institution of Electrical Engineers, Victoria Embankment, W.C. Presidential Address on "Engineering Considerations in Wireless Telegraphy," Commendatore G. Marconi. 8 p.m.

GEOLOGISTS' ASSOCIATION OF LONDON.—University College, Gower-street, W.C. The following papers will be read:—"On the High Terrace Gravel and on a Palæolithic Implement Factory, Dartford Heath," Mr. R. H. Chandler and Mr. A. L. Leach. "On the London Clay and Bagshot Beds (Passage Beds), and on the Gravel of Shooter's Hill, Kent," Mr. A. L. Leach. The lectures will be illustrated with lantern views. 8 p.m. The Council will meet at 7 p.m., and the Illustrations Committee at 6.15 p.m.

SATURDAY, JANUARY 6TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture V., "The Feeding of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

TUESDAY, JANUARY 9TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture VI., "The Play of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

WEDNESDAY, JANUARY 10TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. "Repairs to Steam and Petrol Vehicles," Mr. D. J. Smith. 8 p.m.

THURSDAY, JANUARY 11TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS: GRADUATES SECTION.—13, Queen Anne's-gate, Westminster. "Balancing," Mr. A. E. Pettit. 8 p.m.

ASSOCIATION OF MINING ELECTRICAL ENGINEERS: LONDON BRANCH.—Junior Institution of Engineers, 39, Victoria-street, S.W. Discussion on the paper, "Electricity in connection with Explosives." 8 p.m.

FRIDAY, JANUARY 12TH.

BATTERSEA POLYTECHNIC.—Battersea Park-road, S.W. "The Measurement of Light," Dr. J. S. Dow. 7.30 p.m.

THURSDAY, JANUARY 18TH.

IPSWICH ENGINEERING SOCIETY.—At the Museum, High-street, Ipswich. "Petroleum and other Mineral Oils: Their History, Production, and Uses," Mr. A. E. Kidner. 8 p.m.

FRIDAY, JANUARY 19TH, 1912.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Halls, Glasgow. The "James Watt" Anniversary Dinner.

INSULATING MATERIAL FOR FOUNDATIONS.—For the purpose of insulating the foundations of machinery so as to avoid the transmission of vibration, and consequent damage to buildings, the Genest Stoessel Insulating Company, of 47, Victoria-street, is introducing a new insulating material known as Korfund. It is made from pure natural cork which is treated in accordance with the firm's patented process. Foundation plates made from this material are supplied in all sizes and shapes, so as to correspond with the areas of the foundations they are required to insulate. They are built up of cork strips which are treated and impregnated, and then securely bound together by an iron frame and internal struts. We are told that the firm's experience goes to show that natural cork, when properly treated, is by far the best insulating medium, for it does not become hard and so lose its elasticity. We are also informed that Korfund has been used with considerable success in connection with foundations of Diesel engines. Although this material has only just been introduced into this country it appears to have been used fairly extensively abroad, and a number of continental engineers are said to have expressed their entire satisfaction with it.

A LARGE CRUISING YACHT.—A special ocean yacht devoted to cruising purposes only is the latest innovation arranged by Harland and Wolff, Limited, for the Royal Mail Steam Packet Company. This twin-screw steamer, called the Arcadian, is to be devoted entirely to passenger accommodation. No cargo hatches will interfere with the sweep of the promenade deck, over 500ft. in length, which runs uninterruptedly from stem to stern, a feature impossible in an ordinary liner. All the public rooms, the social hall, smoking and recreation rooms, reading and writing rooms, &c., are on this deck, and therefore conveniently accessible. All the bedrooms have separate bedsteads instead of the usual berths. Notable amongst the novel features are the tiled swimming bath, 35ft. long, with dressing rooms attached, and the covered gymnasium, with all the latest physical culture appliances. The galleried dining saloon occupies the whole height of two decks, and is furnished with a triple row of windows, which is an absolutely new departure in marine construction. The Arcadian will leave Southampton on the 3rd January for tourist service to the West Indies, and between New York and Bermuda. During next summer she will perform a series of cruises from the British Isles to the Norwegian Fjords, North Cape and northern capitals of Europe. She left Belfast for Southampton on Saturday, the 16th December.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

Pig Iron Optimistic.

PIG iron makers take an optimistic view of prospects. Forward business has been placed freely, and makers will enter upon 1912 with some good contracts. Prices continue to move up steadily. Quotations are exceedingly firm. A considerable weight of metal has been sold for next quarter at higher prices. Smelters, believing that a rising market will be experienced after the turn of the year, are not anxious to commit themselves very far ahead. Staffordshire common is quoted about 50s.; South Staffordshire part-mine, 52s. to 53s.; Northamptonshire, 51s. to 52s.; and Derbyshire, 52s. 6d. to 53s. 6d., these prices covering deliveries up to the end of March next. Other prices are: Staffordshire best all-mine pigs, 80s.; foundry, 87s. 6d.; and cold-blast, 115s. From the bottom, pig iron prices may now be said to have advanced 2s. 6d. per ton—an appreciation which has taken some three months to accomplish.

Appreciation of Iron Prices.

Merchant bars are firm at the recent advance, good qualities commanding £6 15s. to £6 17s. 6d., delivered in the district. The market for lower grade bars is equally strong. The present position of bar iron prices may be fairly described as approaching a "boom" state. The figure quoted above for merchant bars is an increase of 12s. 6d. per ton on the price of three months ago, and current values of nut and bolt iron are an appreciation of 15s. to 17s. 6d. per ton on four months back. The inquiry for best bars is being stimulated by an expected advance in the standard, with the opening of the new quarter. The present rate is £8, at which producers can readily sell all they can turn out.

A Weak Spot.

The galvanised sheet trade is still the weak spot in the finished iron industry. Export business is on a fair scale, but there is not enough to keep the large number of mills fully employed, and therefore competition is keen. Prices are unchanged on the week at from £11 5s. to £11 10s., f.o.b. Liverpool. Makers of black sheets have booked some good orders, and prices are firm, with doubles at £7 15s. to £7 17s. 6d.

Steel Market Bounding.

A very marked feature in the steel trade is the hardening in values of billets and sheet bars, supplies for early delivery being scarce. Bessemer sheet bars are now quoted £5 5s. to £5 7s. 6d., and Siemens £5 7s. 6d. This is an advance of fully 2s. 6d. to 3s. 9d. per ton on recent quotations, and on some transactions of 5s. per ton. Steel makers have come to an agreement about the selling price of steel rivet bars, and a basis price of £6 15s. has been fixed. Producers of sectional steel are well engaged. Rolled steel angles, prices are £6 15s. to £6 17s. 6d.; girder plates, £6 2s. 6d. to £7 5s.; ship plates, £7 to £7 10s.; joists, £6 10s. Steel hoops remain unchanged at £6 10s. to £6 12s. 6d. for the stronger gauges, whilst lighter gauges in Siemens qualities are quoted £7 2s. 6d. to £7 7s. 6d. at works, with the usual extras.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Pig Iron Still Advancing.

THE attendance on the Iron Exchange on Tuesday was rather smaller than the average, but in pig iron the tone has been very strong since our last, with higher prices ranging from 1s. to 2s. 6d. per ton, according to sort. Holders do not care to commit themselves for forward delivery, especially in Middlesbrough brands. Finished iron and steel: Recent advances are maintained. Copper and tin: Copper sheets rule £2 per ton higher, and tin ingots also dearer. Sheet lead: Unchanged.

Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 55s. 6d.; Staffordshire ditto, 57s. 6d.; Derbyshire, 57s.; Northamptonshire, 56s. 4d.; Middlesbrough, open brands prompt, 58s. 4d.; January-March, 59s. 4d. Scotch: Gartsherrie, 64s.; Glengarnock, 62s. (official, 62s.); Eglinton, 62s., delivered Manchester. Delivered Heysham: Gartsherrie, 62s.; Glengarnock, 60s. (official 60s.); Eglinton, 60s. Delivered Preston: Gartsherrie, 63s.; Glengarnock, 61s. (official 61s.); Eglinton, 61s.; West Coast hematite, 66s. 6d. to 67s.; East Coast ditto, 64s. 6d. to 65s., both f.o.t. Finished iron: Bars, £7 5s.; hoops, £7 7s. 6d.; sheets, £8 to £8 2s. 6d. Steel: Bars, £7 to £7 10s.; Lancashire hoops, £7 7s. 6d.; Staffordshire ditto, £7 7s. 6d.; sheets, £8 5s. to £8 10s.; boiler plates, £7 17s. 6d. to £8; plates for tank, girder, and bridge work, £7 5s. to £7 10s.; English billets, £5 5s. to £5 10s.; foreign ditto, £4 18s. to £5; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £79; tough ingots, £64 10s. to £65; best selected, £65 to £65 10s. per ton; copper tubes, 9¼d.; brass tubes, 7¼d.; condenser, 8⅜d.; brazed brass tubes, 8⅜d.; brass wire, 7¼d.; rolled brass, 7¼d.; yellow metal, 6½d. to 6⅝d. per lb. Sheet lead, £19 10s. to £19 15s. per ton. English tin ingots, £204 per ton.

The Lancashire Coal Trade.

There was a rather better feeling on the Coal Exchange and rather more inquiry to meet consumption during Christmas and New Year stoppages. In shipping coal, prices favoured sellers by 3d. to 6d. per ton.

Manchester Association of Engineers.

In conjunction with the Manchester branch of the Institution of Electrical Engineers the members of the Manchester Association of Engineers and their guests spent a very pleasant evening at the Whitworth Art Gallery on Friday last. After being "received" by the two presidents, Messrs. Michael Longridge and Cramp, those present, numbering about 250, had an opportunity of inspecting the splendid collection of works of art while listening to the strains of a string orchestra and vocal selections.

The Gas Supply.

At last there seems to be a possibility of the Manchester Corporation adopting a rational attitude with regard to the supply of gas. At a recent meeting of the Council the chairman of the Gas Committee stated that a large scheme for the alteration of the charges all round, with a view to a substantial reduction in the next financial year, was being carefully considered. I have previously called attention in this column to the absurd attitude taken up by the Corporation on the question of smoke prevention by persisting in making an annual profit of something like £50,000 from the gas consumers, instead of reducing the charges and encouraging the use of coal gas for fuel purposes. Is it too much to hope that some day the Corporation will go a step further in the purification of the atmosphere by doing away with many of the open fireplaces in the Town Hall?

The Proposed New Art Gallery.

The assessors' award upon the competitive plans for an art gallery and free library have been confirmed by the Manchester City Council. The successful architects are Messrs. Crouch, Butler and Savage, Birmingham. One of the conditions of the competition was that in the event of the Corporation not giving any instructions to proceed with the work within twelve months of the assessors' award the selected architect will be paid an additional sum of 400 guineas, which sum, with the initial payment of 100 guineas, will merge in the commission of 5 per cent. if and when the buildings are carried out. In the event of the Corporation abandoning the work altogether—which is within the bounds of possibility—the selected architect will be paid a further sum of 500 guineas, making, with the previous payments, a total premium on the entire competition of 1000 guineas.

The Strike at Crossley Brothers.

I am informed that the number of men on strike at this firm's Openshaw works is less than 700. The principals of the firm have informed the men who are on strike that they are not prepared to discuss affairs until they have returned to work—which is in accordance with the instructions of their own unions. I have had handed to me a leaflet which has been circulated among the workpeople in the Gorton district and which emanates from the offices of the Gorton and Openshaw Trades and Labour Council. This remarkable document states that the men threw down their tools in disgust and left work—knowing full well that they were acting contrary to the terms of agreement, and therefore disentitled to donation benefit—because a speed-man stood alongside several of the men and timed the different operations. Other causes of dissension are that "leading hands of many years' service" have been reduced to subordinate positions, and that the charge of a job which included several journeymen was given to an apprentice rated at 11s. per week. The pamphlet states that "no self-respecting man could tolerate such an indignity." Having been refused the support of their own union, the strike committee are appealing to the other unions for subscriptions.

BARROW-IN-FURNESS, Thursday.

Hematites.

The past week has seen a continuance of the strength that was recently imparted into the hematite pig iron trade. The demand for iron has been a little more healthy, and an increased amount of business has been done by makers, not only on prompt account, but for forward deliveries, a feature that has not been apparent for some time. Local steel makers' requirements are about the same, but on outside account more business is moving, and now the whole of the make of iron is going into use, and some iron has been withdrawn from store. Makers are quoting 67s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron, and special grades for which there is a steady request are up to 72s. per ton. It is quite likely that the output of iron will be increased shortly. Business has been done to some extent in warrant iron during the week, and the stores are 500 tons down, to 51,214 tons. Sellers are quoting 64s. 5d. per ton net cash, with buyers offering a shade less.

Iron Ore.

The iron ore trade is well employed, and raisers are experiencing a fuller demand for their ore. Prices are higher, too, with good average sorts at 15s. per ton, and the best ores of the Hodbarrow class are at 22s. 6d. per ton net at mines. Spanish ores are being imported at 20s. to 21s. 6d. per ton delivered to West Coast works. Irish ores are not often imported. Some good shipments continue to be made of Cumberland ores, especially to Scotland; but not much Furness ore is going away by sea.

Steel.

The steel trade is presenting no new features. The rail mills are pretty busy. At Barrow orders are being turned out for home and colonial buyers, and a colonial order is still keeping the mills at Moss Bay busily employed, and they are likely to remain so. The demand for rails is steady without being particularly brisk, but sufficient contracts come to hand from time to time to keep the output much the same as it is at present. Heavy sections of rails are quoted at £5 12s. 6d. to £5 15s. per ton. For light rails at £6 5s. to £7 10s. there is not much trade on offer. Tin bars are a fair trade on home account. For steel shipbuilding material there is a good steady demand, and ship plates are at £7 to £7 2s. 6d. per ton, with boiler plates at £7 15s. to £8 2s. 6d. per ton. The hoop mill is busy at Barrow.

Shipbuilding and Engineering.

These trades are very busy. The huge armoured cruiser Princess Royal is being rapidly fitted out, and several of her big guns have been mounted, her engines and boilers fitted, and this week the two funnels have been placed into position and the masts stepped. No new orders are reported.

Fuel.

There is a steady demand for coal with steam sorts at 12s. 6d. to 16s. per ton. East Coast coke is in good request at 20s. to 21s. 6d., and South Wales coal is quoted at 21s. per ton delivered.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

General Conditions.

A VERY cheerful tone prevails throughout the local iron and steel trades. Business at the moment is restricted by the approach of the Christmas holidays, but this is usually the case, and in most quarters it is believed that prices will continue to move upwards in the new year. Local consumers of pig iron are fairly well covered for supplies, but there is a good weight of business to be done, and it is expected to come forward early in January. All the large local manufacturing concerns will carry over into next year a fairly well-filled order book, whilst special lines are assured of active employment for a considerable time to come. Many of the local firms will be engaged in stock-taking at the year end, and consequently supplies of raw materials are being restricted, but in other cases the holidays will be curtailed as much as possible.

The Coal Trade.

The activity in the steam coal trade shows no sign of abatement, a large tonnage being forwarded to the shipping ports, and to home industrial concerns, and to the railway companies. There is a ready demand for all the coal that is produced, and full time is the rule at the pits. It is very difficult to obtain any weight of fuel in the open market owing to the heavy contract deliveries, most of the large consumers taking extra quantities to tide over the holidays. For accommodation lots to complete loadings shippers are paying higher rates. Current prices:—Best South Yorkshire hards, 10s. to 10s. 6d.; best Derbyshire, 9s. 6d. to 10s.; seconds, 9s. to 9s. 6d.; steam cobbles, 8s. 9d. to 9s. 9d.; steam nuts, 8s. to 9s., all per ton at pits. Current requirements of gas coal are at the maximum.

Slacks.

Contracts for slacks over next year are being readily renewed at advances of 6d. to 9d. per ton, whilst current requirements have been on a heavy scale. There is practically no supply of this class of fuel on the open market, at any rate so far as the best qualities are concerned, and contract deliveries are in arrear. Quotations:—Best washed smalls, 6s. 3d. to 6s. 6d.; best hard slacks, 6s. to 6s. 3d.; seconds, 4s. 6d. to 5s. 6d., all per ton at pits.

House Coal.

Although there is still little or no buying of a speculative nature, the house coal market has been somewhat more lively, chiefly owing to larger pre-holiday demands. London merchants have drawn more freely on contracts, and, generally speaking, merchants have apparently been increasing their floating stocks in anticipation of a better depôt trade prior to the Christmas holidays. There is still a good deal of trouble in getting supplies away from the pits owing to the dearth of empty wagons, but as a rule pits have worked full time. There are no stocks on hand. Prices remain about 9d. to 1s. 3d. per ton above contract rates, showing a reduction of 1s. 6d. to 2s. per ton compared with the market prices ruling in September, but collieries will not sell forward at present prices.

Pig Iron.

Owing to the approach of the holidays and the end of the year business in pig in this district is on a smaller scale, but there is no weakness in the market. Full rates are quoted, and in many instances an additional 3d. to 6d. per ton is asked. Current quotations:—Lincolnshire, No. 3 foundry, 52s.; ditto, forge, 51s.; ditto, basic, 53s. 6d.; Derbyshire, No. 3, 51s. to 52s.; ditto, forge, 49s. 6d. to 50s. 6d., all per ton delivered Sheffield or Rotherham. Hematite: West Coast, 77s. to 78s., less 2½ per cent. discount; East Coast, 72s. to 73s. net. Bar iron, £7 5s.; hoops, £7 5s.; basic billets, £5 5s. to £5 10s.; Bessemer high-carbon billets, £6 15s. to £7.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

THAT a "boom" is at last in progress in the Cleveland pig iron trade is generally conceded, and it is months since so buoyant a tone was apparent. Everything seems to point to continued improvement in business, and consumers are therefore strongly disposed to buy for forward delivery, as there is reason to believe that the longer they wait before distributing their orders the more they will have to pay. The extraordinary shipments strengthen the position of sellers, as do the continued decrease in the stock in the public stores, especially as these remarkable statistics come at a time of the year when quietness is the rule. Owing to the operations of speculators in Cleveland warrants, the prices early this week eased a little from 49s. 7½d. cash buyers—they dropped to 49s. 6d., and this rather checked business, but steadied the market, which was not altogether an undesirable thing, for quotations had been tending to run up too fast. When the weaker operators were cleared out the upward movement was resumed, and on Wednesday 49s. 10d. cash buyers was attained, a figure only 3½d. below the maximum price of the year, that being reported last January. It certainly appears likely that before the year closes the actual best price of the year will have to be reported. No. 3 Cleveland G.M.B. pig iron has advanced to 50s. 3d. per ton for January f.o.b. delivery, which is equal to the highest figure ever reported in 1911, and 51s. 6d. is asked for delivery over the first quarter; but with producers there is no pressure to sell, as the order books are well filled already for as long ahead as the makers care to commit themselves in the face of a rising market. No. 1 is up to 53s. 9d. per ton for January delivery, No. 4 foundry at 49s. 9d., No. 4 forge at 49s. 6d., and mottled and white at 49s. 3d. There has been a very large business in Cleveland warrants this week; indeed, on Monday at Glasgow fully 42,000 tons changed hands, 35,000 tons at one market. Outsiders have been tempted to have a deal in them, and a more than ordinary amount of speculation is in progress, which is not in the best interests of legitimate trade, as the movements in prices become erratic. There is, however, a great deal of legitimate business behind the speculation, which should carry prices up substantially when the new year is fairly entered upon. Traders, therefore, consider the outlook for 1912 very encouraging.

Hematite Pig Iron.

Further advances have been made in the quotations for East Coast hematite pig iron, and prospects are so encouraging of still better prices ruling and of active trade that consumers are very keen to buy for forward delivery. A good legitimate business is being done, but producers are not much disposed to tie their hands for forward delivery in the face of a strong upward movement. They have pushed prices up rather rapidly, for whereas towards the middle of November mixed numbers could be got readily at 60s. 6d. per ton for early delivery, that being the minimum price of the year, they are now being quoted and realising 65s. 6d. for next week's delivery. 66s. for January, and 67s. 6d. for delivery over the first quarter of the coming year, these being the highest figures that have been reported during 1911. Prices have thus gone up with a run, but the makers are in the fortunate position of not having to compete with warrants, seeing that there are none now, and speculators are not the arbiters of prices; the better prices are brought about by legitimate trading. Continued activity in the demand is expected for next year, the prospects of the steel trade being so good.

Ironmaking Materials.

The prices of furnace coke continue to rise, not so much because the demand increases, as because the supply is curtailed. As a matter of fact the coal can be sold to better advantage to the general market than to those who want to convert it into coke, and thus the supply to the coke ovens is lessened, until the quantity of coke that is available is rather short of requirements. This has led producers of coke to put the price of furnace coke up another 1s. this week, and now those who were selling it at 14s. 6d. delivered Middlesbrough over the summer and early autumn are now asking 17s. per ton, the best price of the year. Additional ovens would be re-started, but there is the difficulty of getting the coal for them. Ironmasters are still slow about buying Rubio ore, though they have booked heavy orders for pig iron, and the nominal price continues at 21s. 6d. per ton for c.i.f. delivery. The rate of freight Bilbao to Middlesbrough is slightly easier than it was, 6s. per ton being now the figure, and it is expected that that will be maintained. Mostly at the close of the Baltic season there is such an accession of steamers for the ore trade that a relapse of freight rates occur, and some of the vessels are laid up for the winter. But that is not the experience this year. There is no plethora of steamers; on the contrary, there are not enough offering, the trade of the world having increased so much that more vessels than are even now available are required. Imports of foreign ore into this district are larger than they were in October and November.

Extraordinary Shipments of Pig Iron.

The feature of the market which is at present claiming most attention is the extraordinary shipment of pig iron from the Cleveland district, a fact which is helping on the improvement in the demand. Never have there been such exports in December, which is almost always a dull month as far as shipments are concerned, but this year is 25 per cent. better than the best previous month this year, which was May. On Monday this week no less than 16,609 tons of pig iron were cleared, that being the best shipment on any day in the history of the trade, with the exception of May 12th, 1907, when the quantity was 21,154 tons, but that was in the "boom" year, and, moreover, in the spring season, which is always a busy time. Another big shipment was announced on the 4th inst.—14,434 tons. What was also remarkable about Monday's shipment was that 11 730 tons only of the 16,609 tons were dispatched to Italy—a record quantity, these being induced by the slight easing in the high rates of freight, and the fact that the consumers over there, who have been taking comparatively little of late, and have got short of supplies, can no

longer wait. Very extensive shipments of pig iron are also reported to Japan, that having been a characteristic of the year, and Japan lately has been the largest foreign market for Cleveland pig iron. Fully 120,000 tons will have been sent this year, or 10,000 tons per month. The exports of pig iron this month to 20th reached 97,086 tons, as compared with 53,565 tons last month, 52,590 tons in December last year, and 53,948 tons in December, 1909, all to 20th.

Manufactured Iron and Steel.

There is no abatement of activity in the finished iron and steel industries, nor is it likely that there will be for a good many months, as the order-books of manufacturers are very well filled, and now the tendency of prices is decidedly upwards—in fact, in several branches the example of the plate and angle producers has been followed, and some rise in the quotations has been made. Thus the price of galvanised and corrugated steel sheets has been put up by local firms to £11 10s. for 24 gauge delivered f.o.b., less 4 per cent., the demand being quite as great as the manufacturers can cope with. Black sheets are likewise up to £7 10s., less 2½ per cent. f.o.t. Steel joists are at £6 10s., less 2½ per cent. f.o.t. Heavy steel rails are firm at £5 12s. 6d. net f.o.b., and not for years has there been so large an output.

Shipbuilding and Engineering.

There never was a time when the shipyards of the North-East of England were as fully occupied as they are at present, and yet the builders cannot turn out steam fast enough to please the owners, who are naturally in a hurry to make the most of the high rates of freight that are now ruling. The trouble now is a scarcity of skilled labour, and never was it so difficult to find as it is at present. More particularly is there a shortage of riveters—a shortage which is common to all shipbuilding districts. There has been more work booked than can be executed according to contract with the existing staff of men. The engineering establishments are likewise uncommonly busy.

Coal and Coke.

The coal trade continues extremely brisk, so much so that the collieries can hardly satisfy the demands made upon them, more especially for gas and bunker coals. The latter are required in extra large quantities, not only for home use but also for export to coaling stations abroad, and good ordinary Durham bunkers are quoted at 12s. to 12s. 6d. f.o.b. Tyne dock, while best gas coals are up to 12s. 9d. to 13s. f.o.b. with seconds at 11s. 9d. to 12s. The improvement in trade has led to the reopening of the Woodhouse Colliery, near Bishop Auckland, by Messrs. Sadler and Co., Limited, who have also opened a new colliery in the same neighbourhood to be known as the Etherley Dene. Coke is in very good demand, and prices thereof are moving up, foundry coke to 18s. 6d. f.o.b., and furnace coke to 17s., delivered at Middlesbrough works.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

Large Business in Pig Iron Warrants.

THE business in pig iron warrants in Glasgow Exchange has been expanding in an extraordinary manner. Last week's transactions reached 100,000 tons, and on the first three days of the present week about 95,000 tons changed hands. A further substantial rise has taken place in prices, and although there have been occasional reactions, attributed to dealers taking profits, the market has shown a remarkable amount of buoyancy. A marked increase in shipments of Cleveland iron has given support to the revival of demand, but the attention given to warrants at all iron centres has proved much greater than for a long time past. Since the beginning of November the price of Cleveland warrants has advanced about 3s. 6d. per ton. Since last report business has been done from 49s. to 49s. 8½d. cash, 49s. 3d. to 50s. one month, and 49s. 10d. to 50s. 7d. three months. A large amount of business has been done for future delivery, including 48s. 11d. thirteen days, 49s. 1d. and 49s. 2½d. twenty-two days, 49s. 7d. and 49s. 9d. for 15th February, 50s. for March 6th and 8th, and 50s. 2½d. two months. There has also been a fair business in Cumberland hematite warrants, which have sold at 64s. and 64s. 4½d. for cash, 64s. 11d. one month, and 65s. three months for delivery at Cumberland ports.

Scotch Pig Iron Trade.

The demand for Scotch pig iron has not been much greater than usual. Holidays being so near purchasers for prompt delivery have only been taking moderate quantities. Prices are again higher, however, in sympathy with the state of the warrant market. Govan and Monkland, f.a.s. at Glasgow, are quoted, Nos. 1, 58s.; Nos. 3, 57s.; Carnbroe, No. 1, 62s.; No. 3, 58s.; Clyde and Calder, Nos. 1, 63s. 6d.; Nos. 3, 58s. 6d.; Gartsherrie, No. 1, 64s.; No. 3, 59s.; Summerlee, No. 1, 64s.; No. 3, 60s.; Langloan, No. 1, 65s.; No. 3, 60s.; Coltness, No. 1, 82s. 6d.; No. 3, 59s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s. 6d.; No. 3, 56s. 6d.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 60s.; Dalmellington, at Ayr, No. 1, 59s.; No. 3, 57s.; Shotts, at Leith, No. 1, 65s.; No. 3, 59s.; Carron, at Grangemouth, No. 1, 65s.; No. 3, 60s. per ton. There are 84 furnaces in blast in Scotland, compared with 86 at this time last year. Large deliveries of Scotch hematite are being made under existing contracts. For new business prices are very firm, makers now quoting 68s. 6d. for West of Scotland delivery.

The Finished Iron Trade and Amalgamation.

Definite progress has at length been made with the scheme for amalgamating the makers of finished iron. Several meetings have recently been held to further the enterprise, and the makers have been all the more anxious for a combination of interests owing to the difficulty of obtaining anything like adequate prices for their products. They are now reported to have signed a provisional agreement for an amalgamation, the number of firms embraced in it being fourteen. During the holidays, when the works are closed, valuations and audits will be made at the various works, and it is expected that the completion of the combination will not long be delayed. Several firms are said to have decided for special reasons to remain outside the amalgamation; but they are expected to co-operate rather than offer any opposition in conducting their business. In the meantime, the works have practically full employment. In view of the rise in prices of raw material and the general improvement in trade, higher quotations have been given in the last few days for future business, £6 5s. to £6 7s. 6d., and even £6 10s. being mentioned as likely figures for crown bars, less the usual 5 per cent. discount.

Heavy Orders in Steel.

The opportunity given to the trade to place orders prior to an all-round advance of 5s. per ton in steel prices has brought out a very gratifying amount of business. The shipbuilders and other consumers have generally refrained from fixing themselves definitely to certain makers, notwithstanding the offer of a 5s. rebate; but very large purchases of steel have been made by merchants for delivery during the first half of the coming year. Orders placed are said to be the largest ever known in the history of the steel trade, and the steel makers have now the assurance of full employment during the next six months at least. The position of business on the Continent has tended greatly to facilitate the placing of orders with home makers. Owing to the general activity there foreign makers had recently become extremely dilatory in meeting their engagements, and it is said that merchants have on this account cancelled a considerable amount of material that was to be imported, and replaced it by orders given to home producers. Merchants have also been purchasing quantities of ship and boiler plates for shipment to Norway, Denmark, and other parts of the Continent. There is no difficulty now in obtaining specifications for the manufacture of steel, and the works are so busy that it is not unlikely the holiday period may be less protracted than usual. Sheets and a variety of steel material are on order for the Colonies, South America, and elsewhere. The sheet makers are reported to be full up for a period of two months. The tube making department is extremely busy, home and export orders being alike satisfactory.

The Coal Trade.

There has been no abatement this week of activity in the coal trade. The great bulk of the deliveries are those which had been placed within the last few weeks for execution prior to the holidays, and the pressure to have these completed has been very great. Apprehensions of a strike of colliers have not operated to the extent that might have been expected. Merchants and shippers were quite aware that, even with a national strike determined on, it could not take effect for a considerable time, so that they have generally been addressing themselves only to the requirements of the present. As to deliveries over the early months of the coming year, there has been comparatively little done, mainly because parties have not been able to see their way to an agreement regarding prices. Current quotations are high and strong. Steam coal is quoted, f.o.b. at Glasgow, 10s. to 11s.; ell, 11s. 6d. to 12s.; splint, 12s. to 12s. 6d.; treble nuts, 10s. 6d. to 10s. 9d.; doubles, 9s. 9d. to 10s.; and singles, 9s. 3d. to 9s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade, Cardiff.

THE present time will be long remembered in connection with the Welsh coal trade. Most of the principal coal owners had full order books, but business was hampered by the failure of steamers to come in to their appointed time, and such was the accumulation of stocks that large pits for several days were stopped. This accumulation of stocks effectually interfered with buyers and sellers, and few could take advantage of spot delivery. For shipment in late December and early January, sellers held firmly to their quotations, and it was said on 'Change were disposed to ask higher figures. With respect to contract business, the topic of the week was the result of the tendering for the French State Railway orders; French and German shippers secured the orders for large, and Welsh coalowners obtained the small coal portion at prices understood to range between 16f. 45c. to 17f. for delivery to North French ports. The price was inclusive of the French import tax, and penalties were provided for an excess of 13 per cent. of ash. It was reported that the orders recently secured by Messrs. M. Whitaker for coal on Italian navy account amounted to 156,000 tons. Most of this had been delivered or accounted for. Smalls were held firmly forward, although shippers, to clear wagons, were willing to make slight concessions. There was not much movement in bituminous coal. Households firm. Patent fuel steady. Cokes are quiet.

Present State of Trade.

Latest quotations: Though there was no moderation in the weather the storm had temporarily spent itself, and conditions midweek were a trifle more favourable. Steam took a steadier turn. Tonnage arrivals were enough to keep the loading berths occupied, and there was a strong impression on 'Change that a busy time was coming. Up to Christmas business will be brisk. The outlook of trade is that there is no likelihood of quotations being modified. Some shippers are declining business even on higher terms, some coalowners stating that they have full order books for a month to come. Prices midweek, large and small firm. House coals very firm. Quotations:—Best Admiralty large, 17s. to 17s. 6d.; best seconds, 16s. 3d. to 16s. 9d.; ordinaries, 15s. 6d. to 16s.; best drys, 16s. 3d. to 17s. 6d.; ordinary drys, 15s. 3d. to 15s. 9d.; best washed nuts, 14s. to 15s.; seconds, 13s. 6d. to 14s. 6d.; best washed peas, 12s. 6d. to 13s. 6d.; seconds, 11s. to 12s.; best bunker smalls, 8s. 9d. to 9s.; cargo smalls, 6s. 6d. to 7s. 3d.; inferior smalls, 6s. to 6s. 6d.; washed smalls, 8s. 6d. to 9s.; best Monmouthshire black vein, 16s. to 16s. 3d.; ordinary Western, 15s. 3d. to 15s. 9d.; best Eastern, 14s. 6d. to 15s.; seconds, 13s. 6d. to 14s. Bituminous: Best households, 17s. to 18s.; best ordinaries, 15s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. to 17s. 6d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 9d. to 10s.; No. 2 Rhondda, 13s. to 13s. 3d.; through, 9s. 9d. to 10s. 3d.; smalls, 6s. 3d. to 6s. 9d. Patent fuel, 16s. to 17s. Coke: Special foundry, 24s. to 25s.; foundry, 17s. 6d. to 20s.; furnace, 15s. 6d. to 16s. Pitwood, 29s. to 30s.

Newport (Mon.) Coal.

Midweek: Heavier arrivals improved matters, sellers quoting steadier figures, and are strongly booked. Best black vein, 15s. 9d. to 16s. 6d.; Western Valleys, 15s. to 15s. 6d.; Eastern Valleys, 14s. 3d. to 14s. 9d.; other kinds, 13s. 3d. to 13s. 9d.; best smalls, 7s. 6d. to 8s.; seconds, 7s. to 7s. 6d.; inferiors, 6s. to 6s. 9d. Bituminous: Best households, 16s. to 17s.; seconds, 15s. to 15s. 6d. Patent fuel, 16s. to 16s. 6d. Coke: Foundry, 17s. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 28s. to 30s.

Swansea Coal.

Mid-week: Undertone steady to firm; red vein scarce, prices moving upwards; machine not quite so firm; improvement in cobbles; beans and peas firm; rubbly culm weak; duff unaltered; steam, demand below supply. Latest:—Best anthracite, 21s. to 23s. net; seconds, 19s. 6d. to 20s. 6d. net; big vein, 18s. 6d. to 19s. 6d., less 2½: machine-made cobbles, 19s. 6d. to 20s. 6d.; Paris nuts, 22s. 6d. to 25s. net; French nuts, same; German, same; beans, 19s. 6d. to 22s. 6d.; machine-made large peas, 11s. 9d. to 13s. 3d. net; rubbly culm, 5s. to 6s. 6d. net; duff, 3s. to 3s. 3d. net. Steam coal: Best, 17s. to 18s. 3d.; seconds, 13s. 9d. to 14s. 6d.; bunkers, 10s. 3d. to 11s.; small, 6s. to 7s., all less 2½. Bituminous: No. 3 Rhondda, 17s. to 18s.; through, 13s. 9d. to 14s. 6d.; small, 10s. to 11s.; patent fuel, 14s. 6d. to 15s. 3d., all less 2½.

Iron and Steel.

The close of the year is not usually the time for other business than stocktaking, but at present there is more than usual activity at the mills and furnaces. Latest market quotations:—Pig iron reported at the beginning of the week to have opened firmer and more active, and advices from London favour the opinion that the prospects of the coming year are very promising, and that a larger production of iron will be required to meet the fuller demands of steel makers. Mid-week prices were:—Rails, heavy sections, £5 12s. 6d. to £5 15s.; Bessemer tin-plate bars, £5 to £5 2s. 6d. Iron ore, strong, 20s. 6d. to 21s.; second qualities, 19s. 6d. to 20s. Pig iron: Hematite, mixed numbers, 64s. cash, 64s. 3d. month; Middlesbrough, 49s. 5d. cash, 49s. 8½d. month; Scotch, 55s. 6d. cash, 55s. 9d. month. Welsh hematite, 70s. to 71s., d.d.; East Coast hematite, 70s. c.i.f.; West coast hematite, 70s. c.i.f.

Tin-plate.

Shipments of tin-plate last week were much affected by the weather. The new mills at the Duffryn Works, Morristown, are progressing well. Last week the fly-wheel, which weighs 150 tons, arrived from Manchester. Three of the mills are in readiness, and operations will begin early in the new year. In the Llanelly district tin plates are in good demand, but prices are weakening. Tin bars are an active market, and local make appears to be approved. Latest:—Ordinary sheets, 13s. 10½d. to 14s.; ternes, 24s. 6d.; C.A. roofing sheets, 30 g., £9 to £9 5s.; big sheets for galvanising, 30 g., £9 to £9 5s.; finished black plate, £11 to £11 5s.; block tin, £205 10s. cash, £193 5s. three months. Other quotations:—Copper, £61 17s. 6d. cash, £62 13s. three months. Lead: English, £16; Spanish, £15 10s. Spelter, £26 17s. 6d. per ton; silver, 25 1/16d. per oz.

CATALOGUES.

JOSEPH WRIGHT AND CO., Neptune Works, Tipton, Staffs.—This is a catalogue dealing with chains, cables, anchors, moorings, slings, hooks, stretching screws, rigging and shipping tackle, anvils, vices, pulley blocks, wire ropes, &c.

THE LAMBETH BRASS AND IRON COMPANY, Limited, 91 and 93, Southwark-street, E.C.—A catalogue sent to us by this firm deals with valves and other steam fittings, including cocks, gauge glass fittings, unions, tee pieces, &c. The valves dealt with include spring and loaded safety valves.

GEORGE SWIFT AND SONS, Claremont Ironworks, Halifax.—A new catalogue has been forwarded to us by this firm. It deals with high-speed self-acting, sliding, surfacing, and screw-cutting lathes. The catalogue is admirably illustrated, and the descriptions are clear and concise.

ALLDAYS AND ONIONS, Limited, Great Western Works, Birmingham.—This firm has sent us a catalogue dealing with smiths' hearths of various types, including hearths combined with Roots blowers, forge fans, &c. We note that this firm undertakes the equipment of smithies throughout, including hearths, furnaces of all kinds fired by either coal, coke, oil or gas, blowers, either rotary or centrifugal, exhaust fans for removing the smoke, blast pipes, smoke pipes, pneumatic hammers, lifting tackle, anvils, vices, and small hand tools of every description.

C. REDMAN AND SONS, Pioneer Ironworks, Halifax.—A new catalogue has been forwarded to us. It has reference to Redman's rapid machine tools, and illustrates and describes high-speed planing machines, high-speed hollow spindle slide, surfacing, and screw-cutting lathes, square turret stud lathes, improved shaping machines, drilling machines, &c. In connection with the planing machine section we should mention that different methods of driving planing machines are considered, and that the advantages of the Lancashire Dynamo and Motor Company's system are set forth. Some planing machines designed for special service are also illustrated and described. One of these was made for textile machinery makers having a large number of long rails to plane, and the machine was arranged to machine four at one time.

W. MANSFIELD AND CO., Creewood-buildings, Brunswick-street, and Back Goree, Liverpool.—This is a pamphlet dealing with Mansfield's patented automatic water finder. The principle on which the instrument works is the indicating of the presence of currents which flow between earth and atmosphere, and which, seeking the path of greatest conductivity, are always strongest in the vicinity of subterranean water courses, the waters of which are charged with electricity to a certain degree. In taking observations wooden pegs are placed at intervals of twenty paces in a direction usually south-east to north-west. The instrument is tried over each of these pegs in turn, and should the needle move on any one of them, tests are made all round it, and the spot where the greatest movement of the needle is obtained is where the boring should be made. If the needle does not move subterranean water does not exist under the spot where the instrument is fixed.

WATTS BROTHERS, Cambridge-street and Wellington-street, Sheffield.—The Watts portable boring machine is illustrated and described in a neat little pamphlet forwarded to us by this firm. The machine has been designed to enable cylinders, sleeves, bearing seatings, fly-wheels, pulleys, &c., to be accurately bored without having to transport such articles to works equipped with machinery for carrying out this class of work. The machine is attached to the work to be bored with the aid of parallels supplied, the cutter bar is put out of gear, and by means of a quick traverse the cutter is readily brought to position to commence boring. The gear is then put in, and the cutter revolved through the driving shaft by hand or power, according to the method of driving arranged for. As the cutter is revolved it is carried forward by means of the automatic traverse. The cutter, therefore, continues its regular forward motion along the bore without attention until it is put out of gear or the machine stopped. The cutter bar can be instantly thrown out of gear at any time. The machine can be operated by hand or belt power, and can also, if desired, be arranged for direct driving from electric motor.

BOOTH BROTHERS, Limited, Rodley, Leeds.—A new catalogue dealing with cranes and lifting machinery has reached us. Since the publication of the previous catalogue the firm has developed new designs of cranes worked by electric power, and particulars and illustrations of these are given in this new publication. It should also be mentioned that since the previous catalogue was issued the firm has considerably increased the size of its works, and new and up-to-date machinery has been purchased which enables the firm to turn out work expeditiously. We are also told that the firm is now doing a considerable business in connection with the manufacture of crane motors. The catalogue has reference to electric overhead travelling cranes, electric telphers, cantilever cranes, steam and electric locomotive cranes, portable steam cranes, electric portable gantry cranes, electric portable jib cranes, electric walking or single-rail cranes, hand travelling and breakdown cranes, hand portable cranes for railway work, Dixon's patented balance crane, steam and electric traversers, hand derrick cranes, steam derrick cranes, wharf cranes, steam coaling cranes, steam wharf or deck cranes, steam forge cranes, electric ore-handling cranes, electric cargo winches, portable electric winches, portable steam winding engines, electric capstans, continuous-current dynamos and motors, and motor generators, &c.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

JAMES J. GUEST AND CO., Limited, Newmarket-street, Birmingham, inform us that they have recently erected a new factory, and are now moving into it. The new address will be:—The Charterhouse Works, Northfield-road, Coventry.

FOR the convenience of its electrical customers in London, the Adams Manufacturing Company's London business has been transferred to Balfour House, Finsbury-pavement, London, E.C., to which address all communications regarding Adams' Igranic motor-controlling apparatus should be directed.

A FRENCH contemporary recently described a Wimshurst machine having twenty ebonite plates, each of 72 cm. diameter. The construction is sufficiently good for the machine to stand a speed of 1200 to 1400 revolutions per minute. The output at 250,000 volts is 1 milliamp.; at low voltages the maximum current is 3 milliamps. The maximum spark length between spheres of 6 cm. to 7 cm. diameter is 55 cm. The maximum voltage which has been obtained is about 320,000.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c

(From our own Correspondent.)

Rheinland-Westphalia.

THE general tone of the iron and steel industry is undoubtedly firm. Orders come in freely, and a number of shops are provided with work up to the second quarter of 1912. Business transactions on the pig iron market have been very lively, consumers now purchasing more freely, because it is considered not unlikely that the Pig Iron Convention will raise the quotations for the second quarter of next year. Inland demand in semi-finished steel is satisfactory, consumers' activity having further increased. The Oldenburg Railways have recently placed their requirements in heavy railway material for next year. These are about the same as previously. The requirements of the Mecklenburg Railways, given out at the same time, are rather heavier than usual. On foreign account a fair business is done in heavy rails. Light section rails, too, are in good call, although sales are considerably hampered by Belgian competition. Foreign demand for sectional iron shows a falling off, while on home account a steady business continues to be done. Sales for the first quarter of next year will be effected at the same prices that are now ruling. On the plate and sheet market very long terms of delivery are the order of the day. Bars are in very good call, and hoops show an improvement.

Steel Convention.

The sales of the Steel Convention in November of this year were 488,670 t., as compared with 472 096 t. in October of this year, and 420,306 t. in November, 1910. Of the above-named quantity 161,433 t., as compared with 155,728 t. in October, and 142,049 t. in November, 1910, were semi-finished steel; 182,381 t. railway material as compared with 157,485 t. in October of this year, and 162,450 t. in November, 1910; 144,856 t. sectional iron, as compared with 158,883 t. in October of this year, and 115,807 t. in November, 1910.

List Quotations.

The following are the latest list prices per ton, free at works:—Raw spathose iron ore, M. 11.60; roasted ditto, M. 16.50; Nassau red iron ore, 50 per cent. contents, M. 14.50; spiegeleisen, 10 to 12 per cent. grade, M. 72; white forge pig, Rhenish-Westphalian and Siegerland quality, M. 62; iron for steel making, M. 64 to M. 66 for Siegerland sorts, and M. 67 for Rhenish-Westphalian brands; German Bessemer, M. 74.50; Luxemburg forge pig, free Luxemburg, M. 48; Luxemburg foundry pig, No. 3, free Luxemburg, M. 52 50 to M. 53.50; German foundry pig, No. 1, M. 70.50; No. 3, M. 67.50; hematite, M. 74.50; common basic bars, M. 104 to M. 107; iron bars, M. 130 to M. 133; basic hoops, M. 127.50 to M. 130; common steel plates, M. 127.50 to M. 130; sheets, M. 137 50 to M. 140; drawn iron and steel wire, M. 122 50.

The German Coal Market.

In Rheinland-Westphalia and in Silesia demand has further increased, both locally and on foreign account. Deliveries to the Upper Rhine have continued rather limited, but the South German coal market has maintained the healthy tone of previous weeks. Anthracite is in particularly strong request. The want of wagons, generally, continues.

Austria-Hungary.

In all branches of the iron and steel industry a regular activity continues to be reported, and the number of orders received is satisfactory, securing a fair employment in the shops till the beginning of next year. All descriptions of building material remain in very good call, both on home and foreign account. The locomotive shops are looking forward to being busily occupied for several months to come, because large orders in locomotives are going to be placed later on. Engine as well as house fuel meets with good demand at stiff rates.

Iron and Steel in Belgium.

No changes of importance have taken place on the iron market since last week. The tendency all round is decidedly in an upward direction. Prices are improving steadily, and so is the demand for most articles of finished iron. Pig iron is complained of as being still a little quiet and depressed, but more life is expected to be shown in the new year. The construction shops are well engaged on the whole, and satisfactory prices are being realised. Engine coal has continued in vigorous call, and a fair business is also being done in house fuel, although the exceptionally mild weather has prevented any quick upward movement. Quotations are well maintained both for coal and for coke.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 13th.

THE railways are buying a large amount of equipment covering much of their needs for the coming year. Since November 1st orders for rails total 26,000 tons, and the latest estimate of car orders gives the total at 60,000 cars. These figures include one or two orders that are not definitely placed, but which are assured. Since the 1st of November 250 locomotives have been contracted for, beside some 300 passenger cars, of which 155 are to be furnished for the New York Central Railroad. Renewed activity in plate and structural material is in evidence. A department store in Chicago has ordered 5000 tons of structural material, and a hotel company in Erie has ordered 1000 tons. The Pennsylvania Steel Company will take 7500 tons for a tramway bridge in Portland, Oregon. Car equipment material, such as axles and wheels, is being freely contracted for. The Eastern Steel Company has booked an order for 10,000 tons of sections from the American Car and Foundry Company. An order for 9000 tons of billets has gone to a Chicago mill. Pig iron is being purchased liberally for delivery over the first half of the year, and in some cases for still later delivery. The bar and sheet mills are obtaining more business than for many months past. Stocks of pig iron at the furnaces are steadily declining. The tin-plate industry has increased its production fourfold in twenty years. This is due to the rapid increase in the fruit and vegetable canning industry. Copper has recently advanced in price. Exports for November, 67,020,279 lb.; domestic deliveries for that month, 68,039,776. The quotation for February electrolytic is 12.50.

RECENTLY a paper was read before the Institution of Electrical Engineers by Dr. Robert Pohl, in which he discussed the British Standards for electrical machinery issued by the Engineering Standards Committee. It was first pointed out that these standards had been very largely ignored by the industry, and this was probably due to their unsatisfactory character. Dr. Pohl's principal recommendations were that the standards should be modified to allow of less wearing depth in the commutators of continuous current machinery, and generally to require a less stringent overload capacity, and to permit somewhat higher temperature rises. At present German standards permit a given machine to be rated about 20 per cent. higher than a British, and to have a considerably higher temperature rise. It is certainly desirable that unnecessary overload capacity should be avoided, as it adds to the cost of the machine. This is particularly true of generators driven by gas and oil engines, which possess relatively inferior overload capacities.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

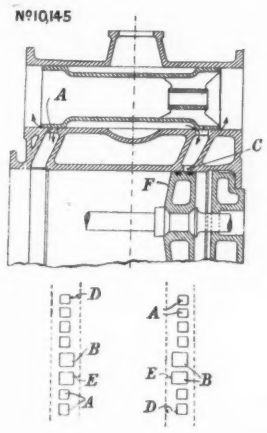
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of the Patent.

STEAM ENGINES.

10,145. April 26th, 1911.—AN IMPROVED VALVE ARRANGEMENT FOR STEAM ENGINES, Richard Ibach, 25, Trierstrasse, Saarbrücken, Germany.

On the valve face are provided ports A of small length for the main admission, and ports B of a greater length for the auxiliary admission, these ports being connected to corresponding cylinder ports C. It will be seen that a larger inside lap D is obtained for the main inlet port, and a smaller lap E for the auxiliary inlet

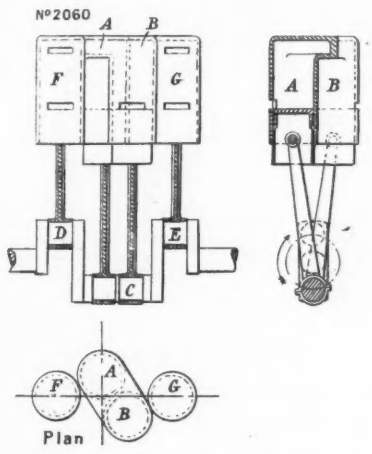


port. In operation, the auxiliary ports would give an early admission, were they not prevented by the ports C being covered already by the piston F so that the auxiliary admission of steam only begins when, during the return of the piston, the ports C are again uncovered. In effect, therefore, the beginning of the admission is controlled by the main ports, and the end of the admission by the auxiliary ports.—*November 29th*, 1911.

INTERNAL COMBUSTION ENGINES.

2060. January 27th 1911.—IMPROVEMENTS IN TWO-STROKE INTERNAL COMBUSTION ENGINES, Albion Motor Car Company, Limited, of South-street, Scotstoun, Renfrewshire, and T. B. Murray, of the same address.

The working cylinders A B are disposed *en echelon* relatively to the centre line of the engine, and drive on to a common crank C. Two cranks D E at 180 deg. to the crank C drive the pistons of



two pumps F G, one on each side of the working cylinders. The throw of all three cranks is equal, as are the masses of all the pistons. Thus complete balance is ensured. The pumps F G are of the piston-uncovered-port type, and deliver air and fuel separately or as a mixture to the working cylinders. Three other modifications are described and illustrated in the original specification.—*November 29th*, 1911.

AERONAUTICS.

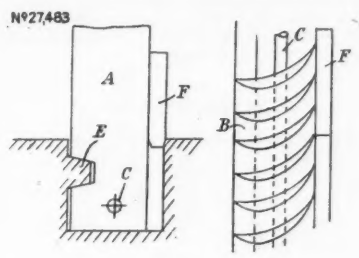
18,866. August 22nd, 1911.—DEVICE FOR CHECKING THE DESCENT OR FALL OF FLYING MACHINES, E. A. Ivatts, 5, Rue Richepanse, Paris.

The only claim attached to this specification makes it sufficiently clear. This is as follows:—In an arrangement for controlling the descent of aeroplanes consisting of the provision of an uninflated balloon or uninflated balloons adapted to be folded up and secured to the frame, the provision of an independent reservoir or reservoirs of liquefied or highly compressed gas or gases lighter than air, flexible tubes for connecting each reservoir and uninflated balloon to one another, and means controllable by the driver for regulating the delivery of gas from the said reservoir so as to inflate the balloon or balloons attached to the frame or to the driver's seat of the aeroplane and check the descent when necessary. There are no illustrations.—*November 29th*, 1911.

TURBINE MACHINERY.

27,483. November 25th, 1910.—IMPROVEMENTS IN TURBINE AND LIKE BLADING, the Hon. C. A. Parsons, Heaton Works, Newcastle-on-Tyne.

The blades A and distance pieces B are threaded on a wire C. A wedge-shaped groove is then cut in the bladed sector near the

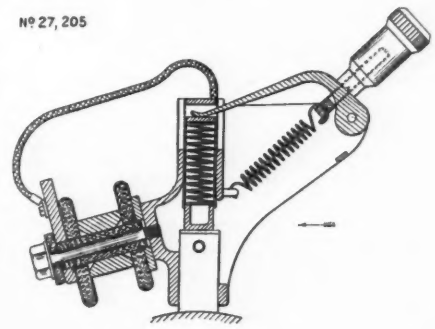


roots of the blades. A corresponding projection E is formed on one side of the recess, into which the blades and distance pieces fit. The recess is slightly narrower than the projection. The bladed sector is forced home on the projection by means of a caulking piece F.—*November 29th*, 1911.

DYNAMOS AND MOTORS.

27,205. November 23rd, 1910.—IMPROVEMENTS IN THE MEANS OF CARRYING BRUSHES FOR ELECTRIC MACHINES AND HOLDING THEM UP TO THEIR WORK AND IN THEIR ELECTRICAL CONNECTIONS, The Electric Construction Company, Limited, of Bushbury, Wolverhampton, and Nicolo Pensabene, of the same address.

The main object of this invention is to avoid the tendency of a brush to stick in a metallic holder and to reduce the pressure which has heretofore been necessary between the brush and the commutator or slip ring. The above objects are effected by interposing a secondary spring between the brush and the main spring, and in-

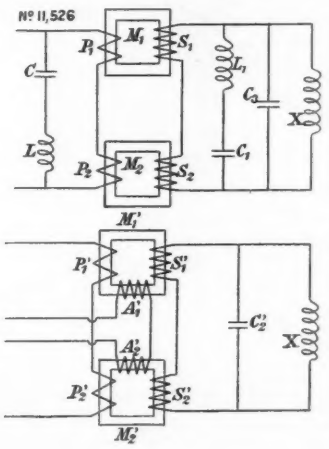


sulating the holder in such manner that no current passes therethrough, the current being conveyed direct from the brush through a flexible conductor or conductors to a collector which is entirely insulated both from the holder and the holder support, whereby the advantage is taken of the damping effect by one spring in relation to the other in checking undue vibration, and a lessened spring pressure on the brush is needed than would otherwise be the case, owing to the avoidance of any sticking of the brush in the holder which results from the ordinary construction in which a portion of the current passes from the brush through the holder.—*November 29th*, 1911.

TRANSFORMERS.

11,526. May 12th, 1911.—AN IMPROVED STATIC FREQUENCY CONVERTER, Oliver Imray, Birkbeck Bank Chambers.

The object of this invention is to transform an alternating current into another alternating current whose frequency is a multiple of the first. The apparatus consists of two separate transformers, of which one at least has a magnetic circuit formed of a ferro-magnetic metal or alloy. The primaries of the transformers are in series and the secondaries also in series, but so that the electro-motive forces which are induced and which have



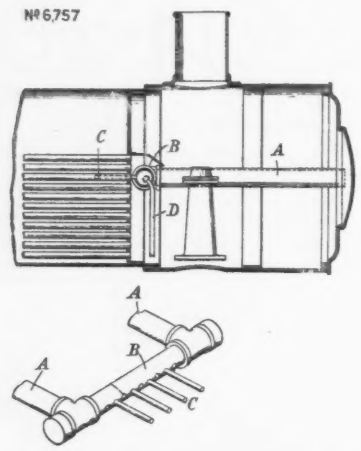
the frequency of the primary current are opposed. Two cases arise according as the required secondary frequency is to be an odd or even multiple of the primary frequency. The upper engraving represents the connections of a static frequency transformer for changing from any frequency to one three times as much. The lower engraving represents the connections for changing from any frequency to one twice as much. In the former case, M_1 and M_2 are the two magnetic circuits, of which one does not contain any magnetic metal, P_1 and P_2 are the primary wind-

ngs, S_1 and S_2 the secondary; L_1 and C_1 are respectively a self-induction and a capacity in resonance for the fundamental period, C_3 a capacity suitable to reinforce the third harmonic. In the lower engraving, M_1^1 and M_2^1 are the two magnetic circuits, each of which is of a ferro-magnetic metal or alloy, P_1^1 and P_2^1 the primary windings; S_1^1 and S_2^1 the secondary windings; A_1^1 and A_2^1 the auxiliary windings of a continuous current circuit, C_3^1 is a capacity suited to reinforce the second harmonic. In the upper engraving a circuit is shown in shunt to the terminals of the whole windings P_1 and P_2, comprising a self-induction L and a capacity C for the purpose of avoiding any disturbance of the primary generator. The coils X represent the external circuits.—*November 29th*, 1911.

LOCOMOTIVES.

6757. March 17th, 1911.—IMPROVEMENTS IN FUEL ECONOMISERS AND SMOKE AND SPARK CONSUMERS, Gardner Clark, South Acton, Massachusetts, U.S.A.

Two pipes A are arranged horizontally along the sides of the smoke-box. The ends of these pipes are open to the atmosphere outside the smoke-box. Their other ends are connected by a cross-header B lying near the front of the smoke-box tube plate. The pipe B is perforated, and from certain of these

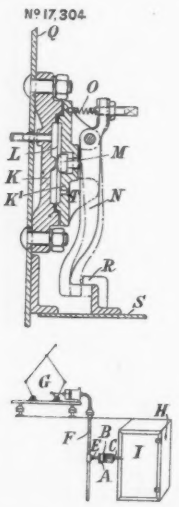


holes short pipes C project backwards into some of the boiler fire tubes. The air rushing through the pipes A due to the motion of the locomotive is in part conducted by the tubes C back into the fire-box, presumably for assisting combustion. The remainder of the air enters the smoke-box by way of the unoccupied perforations in their header B and effects the combustion of the smoke and unconsumed particles of coal coming through the fire-tubes. An injector may be arranged at D for the introduction of steam into the header B to assist the draught.—*November 29th*, 1911.

TRAMWAYS AND RAILWAYS.

17,304. July 28th, 1911.—IMPROVED METHOD OF AND DEVICE FOR LOCKING THE HIGH TENSION CHAMBER OF ELECTRICALLY DRIVEN VEHICLES, *The Allgemeine Elektricitäts-Gesellschaft, of Friedrich Karl-Ufer*, 2-4, *Berlin, Germany.*

A is a cylinder which is connected by the pipe E to the conduit F leading to the compressed air cylinder of the current collector. In the cylinder A is arranged a piston B which may be pushed by compressed air against the action of a spring. The piston-rod C may serve as a bolt for the door I of the high-tension chamber H. So long as there is compressed air in the conduit F, and therefore so long as the current collector G is raised, the bolt C is pushed forward and effectively locks the door I. As soon as the compressed air is released in order to lower the trolley, the

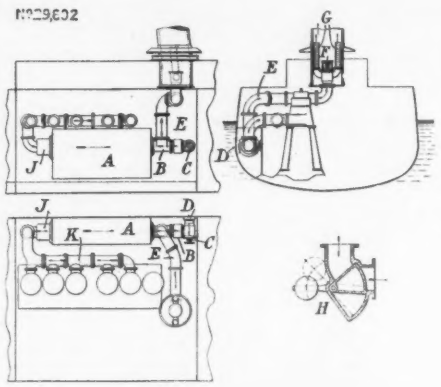


bolt moves back under the influence of the spring D and releases the door. Q is the wall of the high-tension chamber, on the inside of which the device is mounted. Between the two members K and K¹ a chamber is provided across which is stretched an elastic diaphragm L. The space on one side of the diaphragm is in communication with the compressed air pipe, while the other side is open to the atmosphere through the duct T. The diaphragm yields under the influence of the compressed air and pushes forward a push-button M, which forces a hooked lever bolt N into engagement with the catch R, thereby locking the door S. When the compressed air is released the lever N is returned to the open position by means of a spring O. The device illustrated serves only the purpose of preventing the opening of the high-tension door so long as the current collector is in connection with the line.—*November 29th*, 1911.

SHIPS AND BOATS.

29,602. December 20th, 1910.—IMPROVEMENTS IN CONNECTION WITH INTERNAL COMBUSTION ENGINES FOR PROPELLING BOATS AND THE LIKE, James McKechnie, of Vickers, Sons and Maxim, Limited, Barrow-in-Furness.

Where an underwater discharge is provided for a marine internal combustion engine the back pressure of the exhaust may become excessive at times owing to an increase in the head of water above the discharge, which may temporarily take place under certain circumstances, as, for instance, when the vessel is in

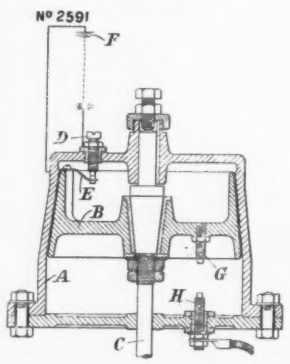


a rough sea. This invention seeks to provide a relief valve which will act automatically when the pressure in the exhaust tank rises above a predetermined amount. When this happens the exhaust is discharged through an auxiliary above-water orifice. The exhaust tank is shown at A. A non-return valve is provided at B, a screw-down valve at C, and an under-water orifice at D. The auxiliary outlet is provided by the branch E leading up to a relief valve F, and silencers G in a funnel. An automatic regulating valve H is, for some reason not specified, fitted at J. This valve "opens only when the pressure in the exhaust main K exceeds that in the tank A by a predetermined amount."—*November 29th*, 1911.

MISCELLANEOUS.

2591. February 1st, 1911.—IMPROVEMENTS RELATING TO ELECTRICAL INFLUENCE MACHINES OR MACHINES FOR PRODUCING STATIC ELECTRICITY, Morris and Lister, Limited, David King Morris, and Ernest Ansley Watson, all of Carlton Works, Lockhurst-lane, Coventry.

This invention relates to electrostatic machines of the influence type, wherein a charge is induced on a carrier plate which is adapted to be so moved that the potential thereon is increased. The object is to construct an improved machine suitable for a variety of purposes in which high-tension current or discharge is required. A closed cylinder A is employed having a conically shaped surface at one end, and within the cylinder is mounted a conical piston B. Preferably the piston is carried by a rod C



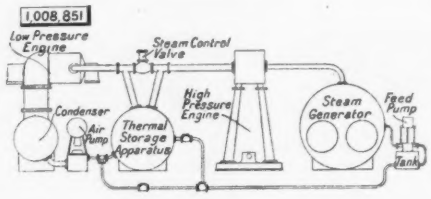
which passes through guides in the cylinder ends. Reciprocation of the piston may be effected by any suitable means. By means of a stud D or ring, projecting within and insulated from the cylinder, and a spring blade E or ring on the piston, the adjacent surfaces of the piston and cylinder are connected to the poles of a voltaic pile F, adapted to produce a considerable voltage, and an electrostatic field is set up between the surfaces. When the piston is moved the pile contact is broken. By the motion of the piston the width of the air gap between its surface and the conical surface of the cylinder is greatly increased, and in consequence the potential of the charge on the piston is correspondingly increased. When the piston reaches the end of its stroke a stud G on the same makes contact with an insulated stud H and the piston is thereby discharged through the external circuit.—*November 29th*, 1911.

SELECTED AMERICAN PATENTS.

(From the United States Patent-office Official Gazette.)

1,008,851. WATER-HEATING AND THERMAL STORAGE APPARATUS, *D. B. Morison, Hartlepool, England.—Filed August 4th*, 1908.

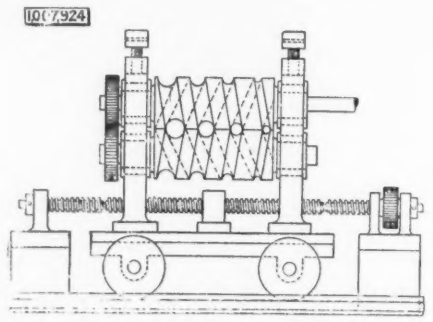
This patent is for the combination of a high-pressure steam



engine, a water-heating and thermal storage apparatus, a low-pressure steam turbine, a pipe for delivering steam from the exhaust of the high-pressure engine to the thermal storage apparatus, and a pipe for delivering steam from the thermal storage apparatus to the low-pressure turbine, and another pipe connected so that steam may be passed from the exhaust of the high-pressure engine to the low-pressure engine without passing into the thermal storage apparatus, and means for automatically varying the ratio of the quantity of steam passing into the thermal storage apparatus to the quantity of steam passing directly from the high-pressure engine to the low-pressure engine with variations in the ratio of the quantity of steam supplied by the exhaust of the high-pressure engine to the quantity of steam taken by the low-pressure engine. There are three long claims.

1,007,924. TUBE ROLLING MILL, *T. Carr, jun., Airdrie, Scotland.—Filed August 6th*, 1910.

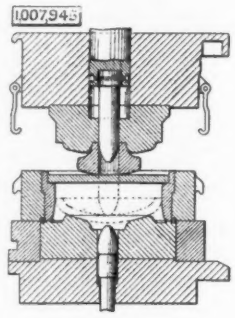
The nature of this invention is rendered obvious by the drawing. The claims, of which there are five, are for the combination with a furnace of rails laid in front of the furnace, a carriage adapted to move in a straight line back and forward on the rails, pass forming



rolls on the carriage, a second set of rails laid substantially at right angles to the first set, a draw carriage carrying a mandril arranged to travel on the second set of rails, and means for moving the first carriage across the front of the furnace at such speed that the working portion of the pass shall remain relatively fixed with the furnace.

1,007,945. MANUFACTURE OF CAR WHEELS, *J. M. Hansen, Pittsburgh, Pa., assignor to Forged Steel Wheel Company, Pittsburgh, Pa., a Corporation of Pennsylvania.—Filed November 11th*, 1909.

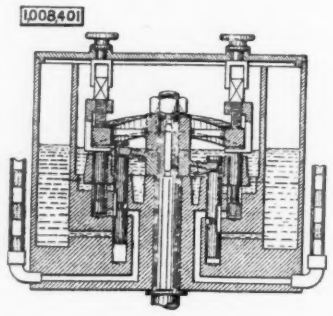
This is one of six patents taken out for the manufacture of railway wheels by stamping steel plates. The improvement consists in preliminarily bending a heated blank into bowl form within



a matrix without thinning the blank, and then by a single stroke of opposing die forging faces forcing a portion of the metal inwardly to develop the hub, forming the web, and forging the rim to completed shape of tread. The claims are thirty-four in number for the whole group of patents.

1,008,401. LUBRICATING SYSTEM, *E. Woerner, Cannstatt, Germany, assignor to the firm of Robert Bosch, Stuttgart, Germany.—Filed May 24th*, 1910.

This patent is for an arrangement for making visible the quantities of oil fed in a lubricating system, comprising a plurality of reservoirs of optically contrasted oil, in combination with a

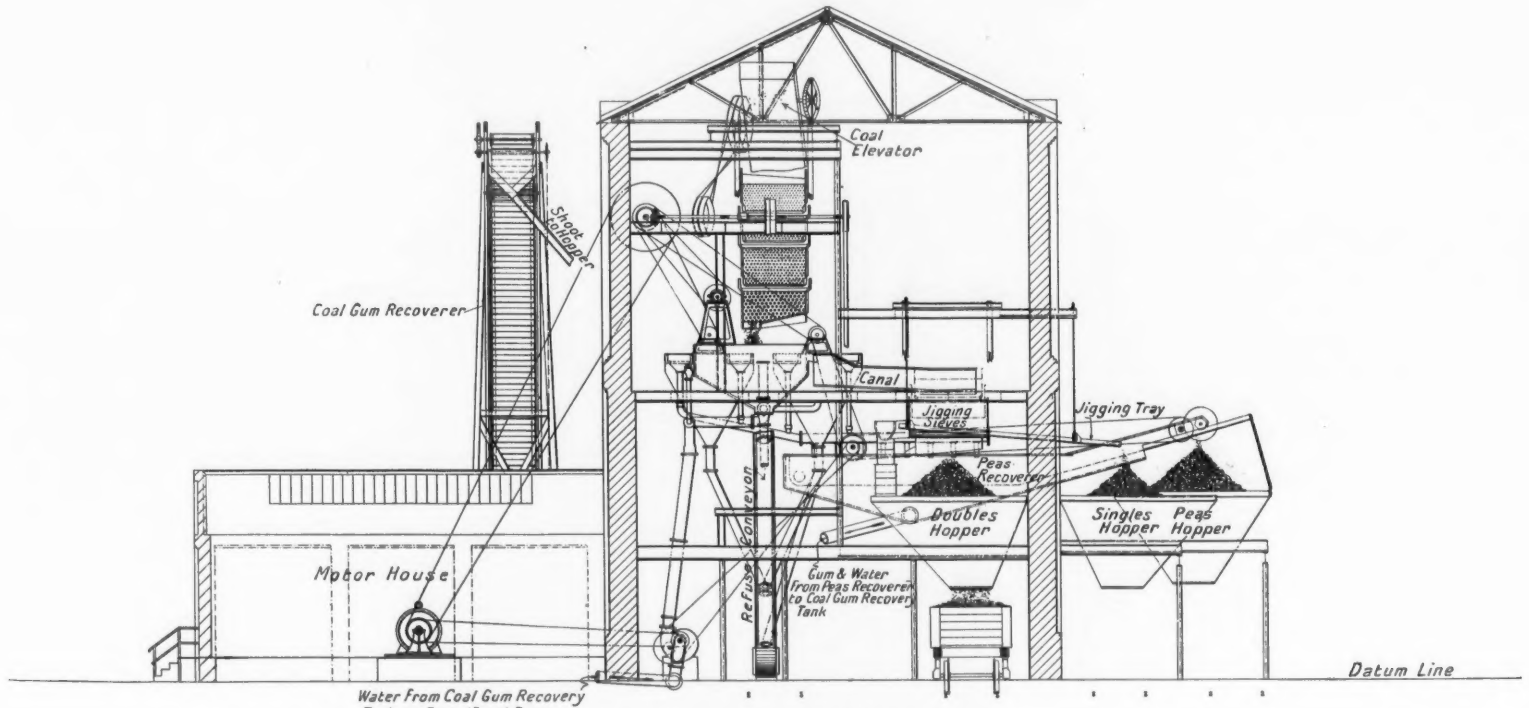


sight tube through which quantities of oil are fed from one reservoir in successive alternation with quantities of oil from another reservoir, whereby the oil passes through the sight tube in the form of successive optically contrasted liquid sections. There are four claims.

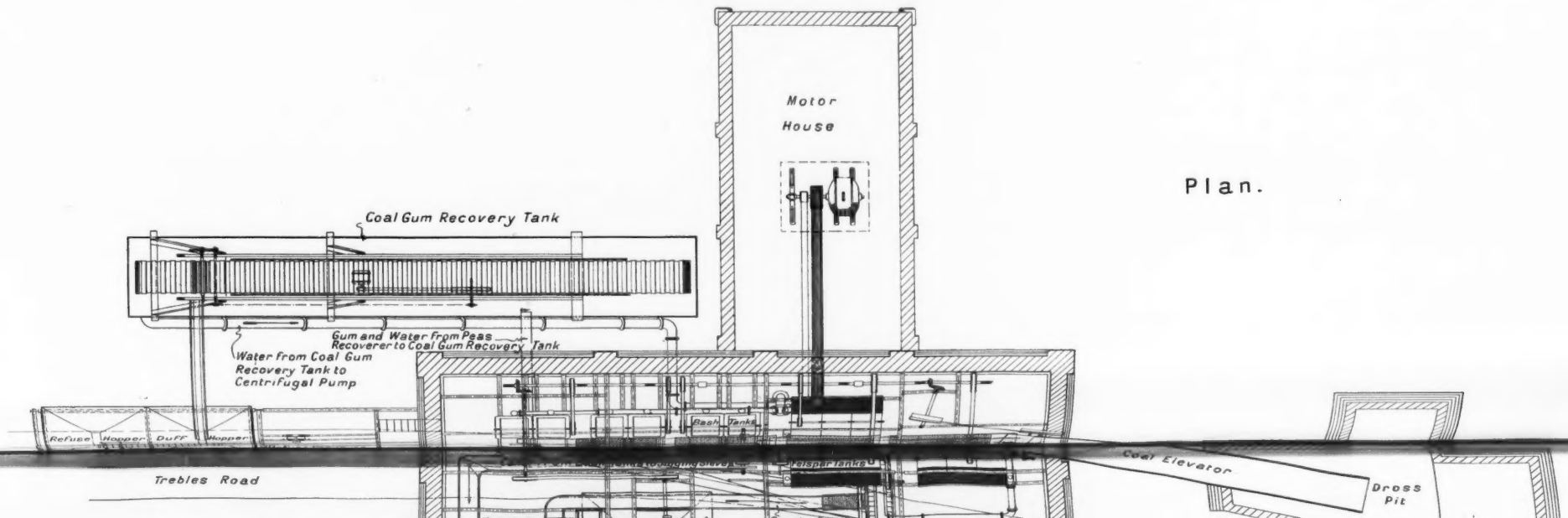
SPEAKING recently at a Letter Carriers' Society at Wellington, New Zealand, Sir Joseph Ward said that a high-power wireless station would be erected in Wellington. It had been intended that the power should be two kilowatts, but that had been extended to five. The station would be powerful enough to get into touch with Western Australia at night time, while in the day time communication could be carried on with ships within a few hundred miles of Sydney. It was contemplated, too, that the system should be extended to the Chatham Islands and Raratonga, the latter place being connected with Tonga. He hoped that before long a system of wireless stations across the ocean between the Motherland and the Oversea Dominions would be perfected.

COAL WASHING PLANT AT THE CRAMLINGTON COLLIERY

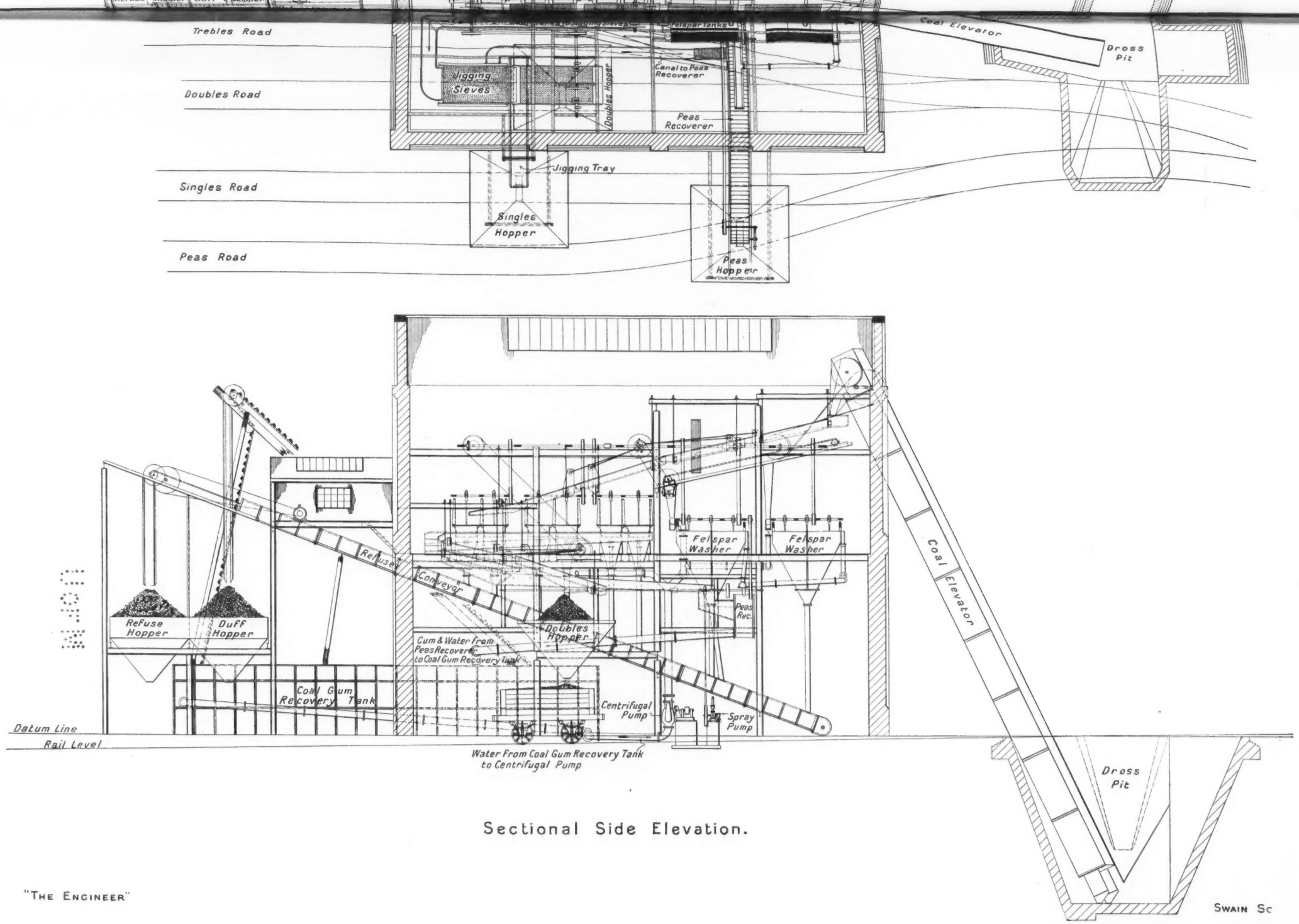
CAMPBELL, BINNIE, REID AND COMPANY, HAMILTON, N.B., ENGINEERS



Sectional End Elevation.


Motor House
Coal Gum Recovery Tank
Gum and Water from Peas Recoverer to Coal Gum Recovery Tank
Water from Coal Gum Recovery Tank to Centrifugal Pump
Refuse Hopper
Duff Hopper
Trebles Road
Coal Elevator
Dross Pit

Plan.



Sectional Side Elevation.

"THE ENGINEER"

SWAIN Sc

SOME IMPRESSIONS OF CONTINENTAL MARINE DIESEL ENGINE PRACTICE.

No. IV.*

THOUGH we have so recently—THE ENGINEER, July 14th, 1911—described the Sabathé motor, we took the opportunity, while in the neighbourhood, of calling to see if this enterprising firm had any new developments sufficiently far advanced for publication, and were interested to learn that a submarine engine, similar to that described by us, had just satisfactorily completed the 10-hour Admiralty tests, and that the consumption was officially returned as 0.38 lb. per horse-power per hour, a really extraordinary result, which would seem to indicate that there is something more in the Sabathé principle than appears on the surface, and that it is not simply a matter of giving more "lead" to the opening of the fuel valve, as in more or less ordinary Diesel practice, as suggested in our previous article. At all events, we have not come across a claim to so low a consumption elsewhere; the fuel used was paraffin, so that on the score of fuel cost there would be little or no gain, but it appears to have been of about the same calorific value as some of the heavier oils, and there does not seem to be any reason why the same figure should not be reached with the latter class of fuel.

We were glad to receive enlightenment on one point as to which we were under a slight misapprehension; we rather feared the expense of making the square holes through the sliding cam blocks used in these engines for reversing purposes—but we were shown the operation, and it largely removed our fears. The metal is first bored out to a diameter a little smaller than the size of the square required; the corners are then slotted out and a special square broach finishes the work. We were also shown a very neat little three-cylinder four-cycle engine on the same general lines as that already described, but of only 45 horse-power at 500 revolutions per minute, designed for use in naval pinnaces, &c. Though a Diesel type of engine of such small size is considerably more expensive to build than either steam or ordinary petrol engines, the idea is to be able to replace the steam sets for the sake of readiness of action and saving of stand-by losses, and at the same time to be able to use the heavier fuels, supplies of which can safely be carried on the parent ship. The engines are built as light as possible throughout, manganese bronze being used for the jackets, framing and bed-plate; the design of the framing permits the trunk piston to be removed from below through large doors. They are not reversible, though fitted with compressed air valves for starting up, which allows of the engine being stopped when the pinnace is required to lie alongside for more than a few minutes, while an ordinary epicyclic type of reversing gear is fitted to give astern motion. A pair of 650 horse-power four-cylinder engines on similar lines for generating purposes were also under construction, but we were informed that very serious attention is being given to the design of two cycle engines of larger power.

The famous firm of Schneider and Co., of Le Creusot, appears to have made extraordinary progress in the building of the Diesel type of engines in conjunction with Messrs. Carels Frères in the three years they have been at work, in that they are now building and have nearly finished engines of 900 horse-power, and others of larger size are in view. Of their somewhat varied designs we are only enabled to describe one—a four-cycle engine for submarines—Fig. 13.

* No. III. appeared December 22nd.

It was rather surprising to find that the best energies of the firm are being devoted to the production of two-cycle engines, and yet to see sets of submarine engines of 300 horse-power on the four-cycle, just where it would be thought that the two-cycle would provide the desirable reduction in weight. This is, however, accounted for by the fact that when Messrs. Schneider and Co. first took up the construction of Diesel engines, they began with that type which was best known, and which appeared at the time to present fewer possibilities of trouble; there has since been such a demand for the four-cycle engine then designed that they have hesitated to alter it. This particular engine has eight cylinders, and runs at 400 revolutions per minute, and will run down as low as 100, and weighs about 67 lb. per horse-power. Both cylinder frames and bed-plate are in this case of cast steel, and the whole engine has been designed to take up as little head room as possible, to which end the stroke is actually less than the bore, and even so there is nothing to spare. Owing to the short stroke there is no difficulty in getting the piston out from below, which is, in fact, the method adopted. There is not a great deal that can be said about the details of the engine except as regards the reversing gear, which is, as far as the actual movements are concerned, quite the simplest we have seen on a four-cycle engine. The cam shaft passes along the engine just below the level of the tops of the cylinders, and with the rods projecting upwards to operate the rockers creates an appearance difficult to distinguish from the Sabathé engine. Like that motor, the Creusot engine has sliding cams on a squared shaft, but here all movements are made with a single hand wheel, except for the throttle. The first motion is to press the wheel inwards towards the engine, which admits air to a series of small servo-motors which lift the rollers clear of the cams; a turn of the wheel shifts the cams along till the compressed air starting cams are in line with the rollers of the four centre cylinders; at the same time a double-nosed cam is moved into line with the exhaust valve rollers of these four cylinders, so that air may act on the two-cycle and provide greater certainty of starting. The hand wheel is then pulled back again; this allows the air to be exhausted from the servo-motors and lets the rollers down on the cams and the four centre cylinders start on air, the outer cylinders taking up the work on oil. When fairly away the movements are repeated, the cam shaft being pushed a little further in till the compressed air cams, and the double exhaust cam on the four centre cylinders, are out of action, and on the return of the hand wheel the rollers are replaced on the cams and all the eight cylinders are on the fuel. Owing to the fact that the cams of the outer cylinders are considerably wider than those of the inner cylinders no alteration has been made in the action of the former. The only thing we do not quite like about the arrangement is that the whole of the cams have to be momentarily put out of gear while the cam shaft is being moved to put the four centre cylinders on oil, so that the engine has to depend entirely on the small flywheel, which is fitted to keep it going till the rollers are returned to the cams. It would seem, however, that there is no actual objection to this in practice. We rather gathered that it is the intention in future to make the cams fast on the shaft and slide the whole shaft, which would be a considerable simplification and much cheaper, as it would do away with the whole of the shaft for sliding the cams, and with the square holes in the cam blocks and the squares on the shaft. In connection with the use of the small servo-motors for lifting the rollers clear of the cams there is, of course, always the possibility of leakage or some mechanical failure to be considered which would put the reversing gear out of action, and it looks as if it might be well worth while to introduce some additional mechanical substitute in place of the air as a stand-by in case of emergency, as on shipboard the power to reverse is a matter which must be put as far as humanly possible beyond doubt. The cams and shaft are not in this case enclosed, though they are fitted with a good guard. We must repeat that we prefer the oil bath, if the design will permit, as with the two-cycle engines built by this firm, but a good guard at least is a *sine quâ non*. We once saw a man's coat caught in a cam of a 500 horse-power engine, and though the man was not hurt, from the explosions which resulted, from whatever cause, and the consequent vibration, it sounded as if the engine was coming down.

We were also shown among other interesting things the big single-cylinder experimental engine built by Messrs. Carels Frères, which has already given 1250 horse-power at 150 revolutions per minute. The reversing is here again by a sliding cam shaft, a servo-motor lifting the rollers off the cams as with the engine already described; only two levers are necessary, and we were informed that this young giant handles perfectly. Verily the day of the big motor-engined cruiser is coming nearer and nearer! A set of electrically-driven Reavell air compressors and a scavenging pump driven in the same way afford every opportunity for experimenting in pressures and volumes so important to the economy of the two-cycle engine.

We are afraid that some of the impressions gathered from such a tour of inspection as that we have now described are not exactly of a nature flattering to our *amour propre* as a shipbuilding and engineering country. Submarine engines have already been built on the Continent almost in dozens. Six thousand horse-power has, according to a French authority, already been put on a single shaft, with the promise of the addition of three cylinders to give the 12,000; 2000 horse-power in a single cylinder nearly completed, 1250 horse-power already running, engines of 1000 horse-power almost a matter of common experience, and, above all, years of absolutely invaluable experience; while here in England it is reported that *something* is being done regarding a cruiser engine and a little has been done as regards submarines, whilst one or two firms have commenced the construction of commercial engines up to 1200 horse-power, but have still all the initial difficulties to overcome. The situation is an extraordinary one, but we are glad to be able to note a very bright lining to the cloud. Though British builders may be somewhat late in the field, they are doing their utmost to make up for lost time, and are tackling the problem with amazing energy on all sides. Now, though there are, say, four firms in Germany, four in France, two or three in Italy, two in Belgium, and one each in Switzerland, Russia, Holland, and America which have already taken up the building of marine Diesel engines, to a greater or lesser extent, many big engineering firms in this country—a dozen at least—have taken up licences and are all doing something; in fact, one of the big firms on the Continent complained that there did not seem to be anyone else here to whom they could grant a licence. When our Admiralty is convinced that the time is ripe—it has bought the Sulzer boat which plied so long on the Thames—to move, and the superintending engineers are converted, things will be able to progress very fast, and leeway will soon be made up, and it is quite comforting to think, in this connection, that, though the Diesel engine was a German invention, it has yet been brought to its present state of progress quite as much outside the borders of that empire as within.

As regards the details, the most important question would appear to be the matter of the choice between the

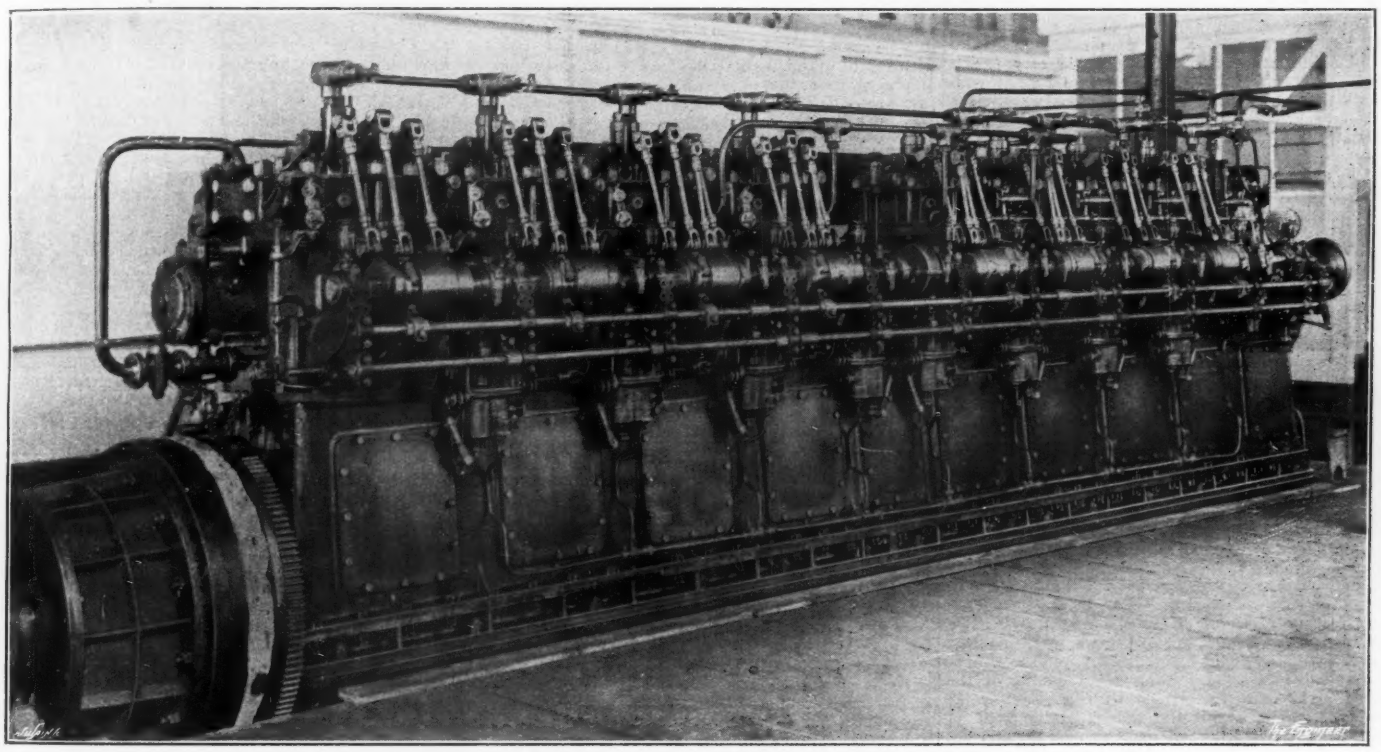


Fig. 13—SCHNEIDER AND CO.'S FOUR-CYCLE ENGINES FOR SUBMARINES

two-cycle and the four. The arguments may perhaps be summed up as follows:—

The four-cycle has an exhaust valve against the simple ports in the cylinder of the two-cycle, but it is superior in economy by about 10 per cent., which does not amount to a great deal. The two-cycle engine has the scavenging air pumps which the four-cycle has not, but if these are part of the main pistons, as with the M.A.N. and F.I.A.T., the additional expense is not very great. On the other hand, the two-cycle has twice the number of working strokes in a given number of revolutions, which means an increase in power of some 75 per cent. or more for a given size of cylinder, and so a given weight, which results in an enormous reduction in cost per horse-power, while as has been brought out in all the engines described, the reversing gear is much simpler. Probably the most important of all for future development is the greater power obtainable from a given cylinder diameter, as it brings the possibility of the largest units appreciably nearer. If it be granted that the two-cycle is in every respect as reliable as the four-cycle, the question becomes simply either "Do I want a unit of power which is greater than can be obtained in a four-cycle engine of to-day?"—a question by itself in which other points will not count—or "Will the saving in first cost, that is in interest on capital, and the saving in weight and space and the added simplicity of the reverse gear of the two-cycle make up for the 10 per cent. better economy of the four-cycle?" The opinion of the above-mentioned continental builders for the larger sizes is, with one exception, in favour of the two-cycle, Carels Frères, Schneider and Co., the M.A.N., Sulzer, F.I.A.T. and Sabathé, while the Nederlandsche Fabriek alone is building the four-cycle up to 1000 horse-power. As the English builders are mostly licensees of one or other of these firms, they cannot affect the argument.

As to the general features of design, Carels, Nederlandsche Fabriek, Sulzer and Sabathé have adopted, or are about to adopt, the open engine with crosshead. The M.A.N. has adopted it for the double-acting engine. English builders, as far as they have gone, for commercial work at any rate, are building it also. Of those who have built the trunk type, Sabathé, Schneiders and Sulzer (in some types) arrange for the piston to be withdrawn from below; F.I.A.T., M.A.N. and Normand, for reasons that have been stated, from above. All adopt piston cooling in some form from about 450 horse-power and upwards, Sulzer with water, Nederlandsche Fabriek with air for 500 horse-power, the others with oil; oil is undoubtedly to be preferred. Forced lubrication is universal, even to the gudgeon pins, with special preventive measures to keep the overflow from reaching the cylinder walls. Filters and coolers are fitted on the lubrication system, the former usually in duplicate to allow of their being cleaned without stopping the engine. Sulzer, Carels, Normand and M.A.N. close in the cam shaft. All firms use a centrifugal governor of sorts acting on the suction valve of the pumps; such a governor has a better chance than on a triple-expansion steam engine as it acts simultaneously on all the cylinders, and therefore requires a smaller movement to cause a given retardation, and similarly all the cylinders at once get to work to pick up instead of the third one having to wait until the first two have had their turn at the motive power. Actual experience in heavy seas is too limited to be able to state positively the result in practice; but we are not very hopeful. The practice with regard to the number of cylinders to which air is admitted for starting up purposes varies greatly, and exact details are unimportant so long as it is absolutely certain that there are no dead points. Compressed air as a means of starting up and reversing appears now to present no difficulties; in four cases—Carels, Schneiders, F.I.A.T. and the M.A.N.—it is actually used for shifting small details of the reversing gear, and if provided with a stand-by as suggested, will meet with the undoubted approval of marine engineers. The actual methods of operation are now quite simple; Carels, F.I.A.T. and the M.A.N. alter the angular relationship of the cam shaft to the crank shaft; Sabathé and Schneider slide the cams, while Normand slides the cam shaft, the Nederlandsche Fabriek has two cam shafts, and Sulzer shifts the cam rollers across the centre line. The movements necessary are so simple that it is difficult to draw any comparisons even if it were desirable. The larger engines are distinctly more noisy than an equivalent steam engine. M.A.N., Körting and F.I.A.T. use an enlargement of the main piston as a scavenging pump. Schneider and Carels use the four-cylinder Reavell air compressor, Sulzer a special arrangement with levers, others having three stage plungers in tandem or opposed. Cast iron is used for the cylinder jackets, frames, and bed-plates of the larger type of engines; steel castings for cylinders and frames are used by Schneiders and Carels, while the M.A.N. use manganese bronze and Sulzer steel columns on a bronze bed-plate for the light type of engine. The tendency is to dispense with the fly-wheel altogether when the number of cranks warrants it. One other point only occurs once, that is the use of double-acting engines, the M.A.N. being the only example we were shown. Whether this is as yet thoroughly and commercially practical it is too early to say, though the 1000 horse-power engine has satisfactorily run on full load; we found all the other firms very much averse even to experimenting in that direction. As with the gas engine, time may bring about an alteration; in fact, the demand for high powers will almost compel makers to face what is not an insuperable difficulty, but there will always be the question of varying the compression for different circumstances, which with the single-acting engine is so simply done by means of a liner under the foot of the connecting-rod.

In effect, we think we may say that our observations have only served to strengthen our faith in the ultimate future of the internal combustion engine afloat for many purposes, and our desire is still more to accelerate the undertaking of what must be, for a time at all events, experimental work on engines of this type on the part of British builders.

THE ECONOMIC POSITION OF THE OIL FUEL QUESTION.

By SYDNEY H. NORTH and G. MAITLAND EDWARDS, F.G.S.

DURING the last two or three years the substitution of oil fuel for coal has in more than one direction made considerable progress. The engineering difficulties associated with its use for power production have been much more closely studied than before, and many of the difficulties encountered in the early stages of the movement have been either entirely eradicated or very greatly minimised. The practical proofs of this are to be found in the great extensions which are taking place in the adoption of oil fuel to industrial purposes. The first steps which were taken when oil was recognised as a superior steam raiser to coal were confined to the naval service, and although here and there it was utilised in delicate metallurgical processes it was found that the appliances were not such as to induce users to relinquish coal for oil. The last two or three years, however, have been marked by a much more widespread movement in its application to industrial purposes, and as this movement has progressed the oil fuel burner and the method of arrangement of the furnace have been considerably improved. These improvements have advanced the economic aspect of burning oil fuel under furnaces. By the close study of the relation of the atomising agent to the oil itself, it has been possible not only to increase the efficiency of the burner, but also to regulate the two agents so as to obtain a much more complete combustion. Concurrently with this, the construction of the furnace has been so much modified as to obtain a more equal distribution of heat than under the older systems. Nevertheless, there is still room for higher efficiency in the direction of getting a greater service from the oil dependent upon purely mechanical problems, in the solution of which little difficulty will be found. It may be accepted, therefore, that the engineering position with regard to the application of oil fuel to steam raising and power producing purposes is sufficiently advanced as to allow of its widespread adoption, provided a supply of oil can be relied upon at such a figure as will compare, all things being taken into account, favourably with coal.

This brings us to the principal obstacle which has to be faced in the matter, and which, after all, is a more difficult problem to solve than that of some engineering detail. The position and natural resources of this country place it in a most unsatisfactory position with regard to the supply of a commodity produced outside its borders. The indigenous fuel supply of the country capable of being drawn upon at a low figure forms a barrier which can only be broken down by the provision of a fuel which can offer initial and ultimate economic advantages far surpassing those obtained with the existing commodity. In the abstract there is no comparison between the two fuels, and the advantages are shown, not only from a physical point of view, but also from a chemical. When, however, such advantages can only be secured by the payment of a much higher price, manufacturers and others refuse to be involved in this, in spite of the fact that the cost of the ultimate product turned out shows a reduction over that when coal is employed. From a strict economic point of view, even with oil at its present price, manufacturers and power users of every description could profitably adopt oil fuel. It must be remembered, however, that the expenditure on capital account in nearly every works in this country has been very extensive, and it can scarcely be expected that until it is possible to show, not only a saving on the finished product, but also the possibility of wiping off a certain proportion of the expenditure incurred on plant, &c., that the substitution of oil for coal will be made. It is not merely the exchange from one fuel to another that the bulk of our manufacturers have to consider. It is the question of either scrapping existing plant and appliances, or of introducing such alterations in these as would make further large demands on capital, that they are faced with. Looking at things in a cold and practical manner, therefore, it appears that oil fuel will make headway either through the extension of existing works, the erection of new ones, or by old plant falling into desuetude, when opportunity might be afforded for the introduction of newer, more economical, and more satisfactory methods.

This argument is, of course, dependent upon the extent to which a continuous supply of fuel oil is available. At the present time this question of supply is in a somewhat peculiar position, and is governed by two important factors. One is that, although the aggregate output of oil, and the quantity available for fuel purposes in different parts of the world, are sufficient to provide for all requirements, not only in the countries in which the oil is produced, but also to meet the additional demands of other large industrial communities, the necessary means of transport are not available, and the charges for this service are so high as to preclude the oil being placed on the market at a figure in any way comparable with that for coal. In the face of this it is practically useless to enumerate the economies which would result from the substitution of oil fuel for coal. That economies are effected there is not now the shred of a shadow of a doubt; it is a proven fact, admitted by all engineers and manufacturers. Only one obstacle, therefore, blocks the way of progress, and that is the high cost of transport, which represents more than two-thirds of its present market price in this country. Every young industry has suffered from this burden, and only the provision of greater facilites of transport can remove this. The Baku oil industry has been frequently in the same dilemma, and the problem here is on a far more important and influential scale, and can only be solved by the provision of a greater number of tank steamers than are necessary to carry a normal demand. This is no strange principle, in connection with the carrying trade in different commodities, for were it not for a surplus of conveyances being available the fluctuations in supply and demand could not be dealt with. This principle will have to be fulfilled in the oil fuel industry before it can be placed on an economic basis common to that of other commodities.

During this period, of what might be termed suspended development, the economic aspect of the engineering branch of oil fuel has made satisfactory and very promising progress, more particularly in the direction of improvements to existing methods and appliances. To a very large extent the engineers who have devoted so much time and labour to the question have saved the situation, and it will depend upon the results of their efforts, at any rate until the economic problems have been solved, whether the oil fuel business continues to progress or not.

The provision of power by means of oil as fuel may be divided into two distincts branches, the one in which the oil is used directly under the furnace, after being atomised, the other in which power is obtained by internal combustion. It is only necessary in this article to enter into a sufficient amount of detail to indicate the truth of the assertions made above, and for this purpose only actually verified practice will be referred to. In locomotive work it has been found that, although there is under existing methods a danger of manipulating the burner in such a manner as to increase unnecessarily the consumption of oil, economies may be effected over long runs, and also in cases where engines are held up at terminals for a considerable time as they frequently are, involving a wastage of fuel which would be obviated were oil burning adopted. The advantage of the latter in the facility with which the supply of oil can be regulated according to requirements is one great point in its favour, as in the use of coal the fire has to be kept up continuously to its normal heat, thus involving an unnecessary consumption of fuel. In the course of the year this fuel saving would amount to a large figure. Another point of economy in connection with locomotive work is that under oil it would not be necessary to cut engines out for flue-cleaning. With regard to marine work a considerable amount of evidence has accumulated indicating the economies which have been effected in recent years by the improvements which have been introduced after a close study of methods and appliances. The latter practice, therefore, shows that as greater experience is obtained in the use of oil as fuel the greater is the economy secured in every direction. On a steamer equipped with a 150 horse-power Diesel engine, carrying oil sufficient to traverse a distance of 750 miles, a speed of nearly 11 knots was obtained at a cost of 1¼d. per mile for a run over fifteen miles, the consumption amounting to between 80 lb. and 90 lb., or between 5 lb. and 6 lb. per mile or 0.4 lb. per indicated horse-power This cost is one-quarter of what it was under coal, while a greater speed, amounting to 35 per cent. over coal, was obtained. On a Japanese liner on which direct oil burning was employed, of 18,500 shaft horse-power the consumption of oil was 1.05 lb. per shaft horse-power, while burning Takashima coal 1.52 lb. was required to produce the same results. It was also ascertained that 14 tons of oil would serve the same power-producing purpose as would between 20 and 22 tons of coal.

In connection with the industrial use of oil for power purposes similar economic results are evidenced. In the sub-station of a tramway company an official test showed that the engine gave 0.664 lb. per kilowatt hour, including 14.5 lb. per hour for friction losses, as the mean consumption, or 0.32 lb. per indicated horse-power on steady full load, the oil costing 50s. per ton, or 0.167d. per unit. At another station it was found that with oil at 52s. 6d. per ton delivered into storage tanks over a period of four months the consumption of oil amounted to one-fifth of a penny per B.T.U. Instances of this character could be quoted not only from records in this country, but also from those of America and other countries.

Again, economic factors in connection with the use of oil for smelting purposes are brought out very clearly by the experience of the rolling mills of the Southern Pacific Railway works at Sacramento, apart, of course, from the question of cost, which is not being considered in this aspect of the subject. At these works 40 gallons of crude oil, as it comes from the well (14 deg. gravity), are required to heat 2000 lb. of scrap metal or pile. In the old coal reverberatory furnaces it required 500 lb. of bituminous coal to heat the same quantity of metal. The output of the furnaces heated with oil is at least 20 per cent. more than with the old-fashioned coal furnace. Moreover, the technical results achieved have shown that there have been 50 per cent. less car axles condemned on account of seamy journals since the works in question adopted fuel oil for heating. This not only occurs with axles, but with all other forgings. This experience may also be duplicated in England. At a certain ironworks experiments were made with billet heating, and the results were of a highly satisfactory character. A billet was heated to a good forging heat in twenty-five minutes, consuming 2.5 gallons of oil, at a cost of 1s. 0¾d.; with coke the same process occupied 1¼ hours, consumed 1¼ cwt. of coke, and cost 2s. 4½d. Under oil fuel the billet was heated equably throughout, which was not the case when coke was the fuel used. These are actual results, and show not only a considerable saving in fuel, but from a metallurgical point of view the use of oil was far more satisfactory. Beyond this, however, there is the saving of labour connected with stoking, loading and unloading the coal, and the saving of time in heating, which means a larger turnout of metal during any period. Another point of economy is the facility with which an oil-fired furnace can be manipulated; heat can be raised in a very greatly reduced time, while the supply of oil can be shut off immediately the work is completed. Perhaps one other instance will be sufficient to serve our purpose in endeavouring to indicate that, apart altogether from the cost of fuel and the disparity at present existing between the cost of oil and coal, the actual economic advantages of the former are unmistakable, and that the solving of the engineering problems connected with its use is clearing the way for the more general adoption of oil as fuel. This last instance, however, which deals with its use at a glass works, proves

THE NORTH-EASTERN RAILWAY COMPANY'S NEW BOILER SHOP

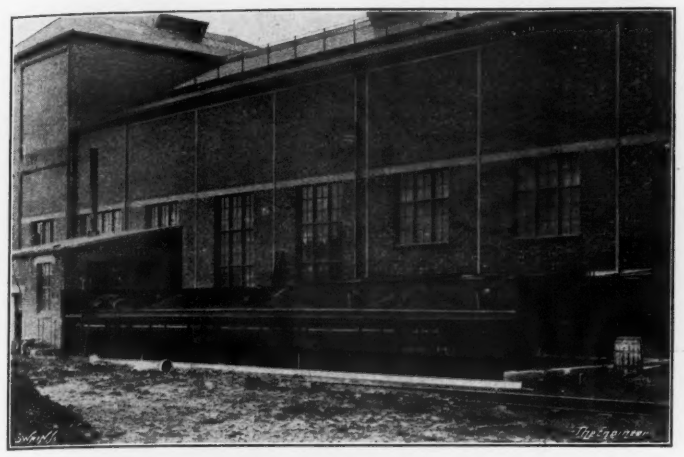


Fig. 1—CHARGING FLOOR OF PRODUCERS

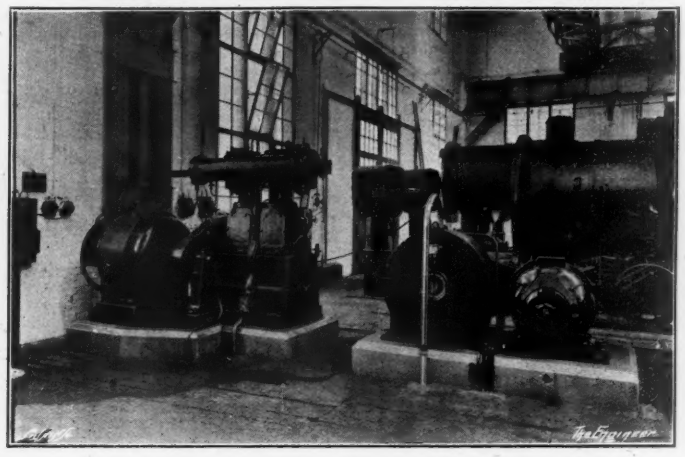


Fig. 2—AIR COMPRESSOR

Fig. 3—BOILER TESTING PLANT

Fig. 4—MARKING-OFF PLATES

that in spite of the present high cost of oil, considerable economies may be effected. At the glass works in question, having regard to various economies in labour and other directions, a saving of 15s. per ton is effected, comparing oil with coke, which means a direct saving of 40 per cent. Furthermore, instead of employing only 48 operatives when using hard fuel, it is possible to employ 72, providing an increased output to the extent of 50 per cent., while the fixed establishment charges remain practically the same. To melt 1 ton of glass, 1½ tons of coke at 20s. per ton are required, or a total expenditure of 30s.; to carry out the same process with oil as fuel, ½ ton of oil is required, which, at 40s. per ton, means an outlay of 20s., showing an actual fuel saving of 15s. per ton, or equal to 60 per cent. In a glass furnace of 6 tons capacity, measuring 10ft. by 5ft. by 3ft. 6in., with a depth of molten glass of 2ft., leaving a space of 18in. from its surface and the middle of the crown, to maintain a temperature of 2500 deg. Fah., 5½ tons of fuel oil are sufficient for seven days, during which period over 12 tons of cold raw materials are melted, or about 2 tons per day for a working week.

A further development in the use of oil has recently occurred which may aid in many directions the extension of the application of oil. This is the introduction of a process for solidifying petroleum, known as the Armstrong-Mordan system. According to Mr. W. Willett Bruce, the President of the Liverpool Engineering Society, the use of this solid petroleum on board a steamer is said to be highly satisfactory from an evaporative point of view, only leaving a residue of 2 per cent., which means an enormous saving, taking the ordinary every-day residue at, say, 15 per cent., and if such saving can be maintained, and its marketable value be not prohibitive, such a fuel's ultimate success is undoubtedly assured. One important feature about this process is that it can be employed in connection with waste coal and other waste material, the resultant product being a fuel of high calorific value. In the case of Russian waste coal, which can be purchased for 1s. 6d. per ton, experiments have shown that by this solid oil process it can be transformed into fuel equal in calorific power to the best steam coal. It therefore appears that this new process may be the means of aiding in the extension of the use of oil, and especially when it is considered that, whatever combination it takes, the heat-producing power of the oil is not diminished.

THE large main engines of the U.S.S. Texas and New York will, it is stated, be fitted with two condensers instead of one. They will use oil only as fuel.

NORTH-EASTERN RAILWAY COMPANY'S NEW BOILER SHOP AT DARLINGTON.

THE new boiler shop recently erected at Darlington by the North-Eastern Railway Company stands at the east end of the Stooperdale estate, and its situation with regard to siding accommodation, connection with various lines of railway and its relative position to the other parts of North Road Works are easily discernible upon the plan—Fig. 5. It is 513ft. long and 219ft. wide, and these dimensions will furnish some idea of the possibilities in the way of output which can be realised in a shop having such ample proportions. Its general arrangement is shown in Fig. 6.

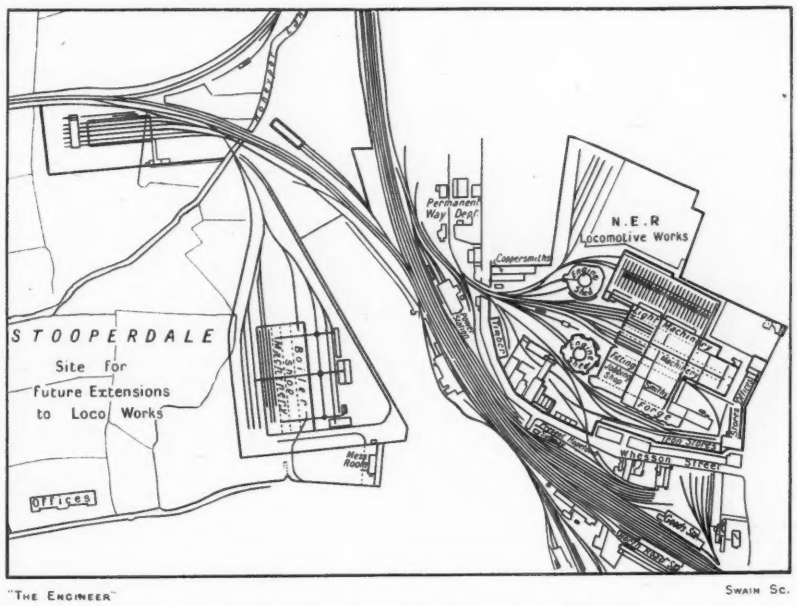


Fig. 5—THE N.E.R. CO.'S DARLINGTON WORKS

The columns and framework are of rolled steel joists braced together; thus, so far as support is concerned, the building is independent of the brickwork and is so arranged that extensions can, if found necessary, be readily carried out. The height to roof principals is 35ft. and to traverser rails 24ft. The cross spans, beginning at the east side are, two 60ft. bays, one of which is devoted to new and one to old boiler work; next, a 30ft. bay containing machinery, and another 60ft. bay at the west side devoted to tender work.

The riveting tower is situated at the south-east corner of the first 60ft. span, and includes a separate crane which runs across the shop at a height of 46ft. 6in. from floor level, at which it is operated from hydraulic cylinders and commands the fixed riveter. This hydraulic boiler-riveting machine—see Fig. 8—has a gap of 17ft. 6in.

and is capable of exerting a pressure on the rivet head of 65 tons. It is also fitted with a reducing valve, by means of which lower powers can be obtained. The machine consists of a strong iron main casting to which the cast steel hydraulic cylinder is bolted. The hob of the machine is also cast steel and is secured to the main casting by large steel bolts and nuts. It is fitted with an automatic power-saving arrangement which effects a saving of at least 60 per cent. of the hydraulic power required to work the machine. It also possesses a patented timing

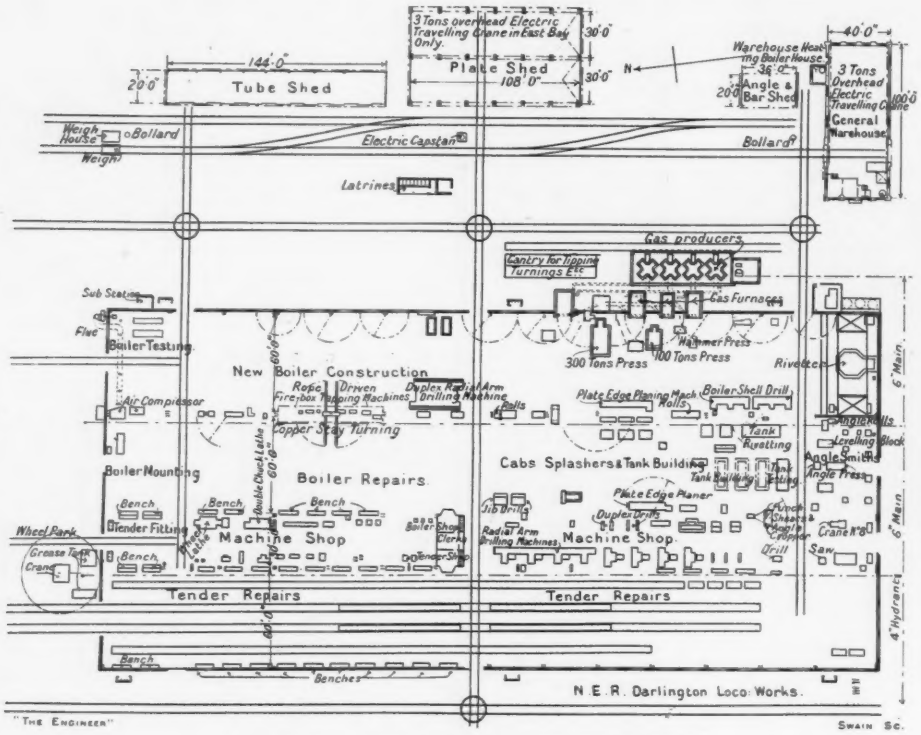


Fig. 6—GENERAL ARRANGEMENT OF NEW BOILER SHOP

arrangement, by means of which pressure is kept on the rivet head for any period up to 45 seconds, thereby ensuring that the rivet is properly closed before the pressure is withdrawn.

The whole of the shafting—which is 3in. in diameter—in the shop is belt driven from 45 horse-power, 440 volts direct-current motors, these being placed in concrete foundations raised above floor level with inclined drives. Arrangements for tightening the bolts are also provided. The main shaft hangers are supported from the traverser girders and are of T steel, 6in. by 3in., which forms a light, strong and economical hanger. Their shape permits of the passing of the shafting between the main columns, inside of which cast iron brackets are fixed. The countershaft girders are of Warren type bracings with channel

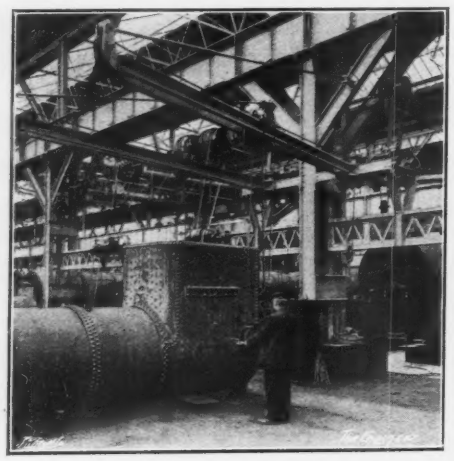


Fig. 7—STAY TAPPING MACHINE

steel as the top and bottom members, and the countershaft brackets can be moved to any position without drilling these members.

At the south-east corner of the building in a separate annexe is a set of three-throw horizontal hydraulic pumps for boiler testing purposes, the plungers being 3½in. in diameter and having a 12in. stroke. The pumps are capable of delivering 50 gallons of water per minute at a pressure of 1700 lb. per square inch. They are driven by an electric motor directly through machine cut gearing, and are fitted with patent automatic control gear consisting of a hydraulic cylinder which operates the electric controller for stopping the motor and pumps when the accumulator has reached its full stroke and starting them again when it has descended. In conjunction with this arrangement there is provided an automatic by-pass valve, also worked by hydraulic cylinders, so that the motor is started up at about 25 per cent. full load, the load thereafter coming on gradually until full load is reached. These are by Hugh Smith and Co., of Glasgow, by whom most of the heavy hydraulic machines in the works have been supplied.

The power for the pneumatic drills and caulking tools is furnished by an air compressor—Brotherhood's—having a capacity of 500 cubic feet of free air per minute. The compressor—see Fig. 2—is of the two-stage vertical type, running at 300 revolutions per minute, is gear driven by a Siemens motor of 105 horse-power, and forced lubrication is supplied to all working parts. Individual motors are on certain machines as under:—One of 23 horse-power on a plate edge planing machine; one of 22 horse-power on a punching and shearing machine—see Fig. 9; one of 12 horse-power on plate rolls; and two of 10 horse-power on duplex radial arm drilling machines. These large machines are all placed in positions most convenient for dealing with their special work.

The flow of material from its raw state to the finished product has been kept steadily in view in the laying down of the machinery. There are in the shop four 25-ton overhead electric travelling cranes with single crab and four motors of the following horse-power:—Travelling,

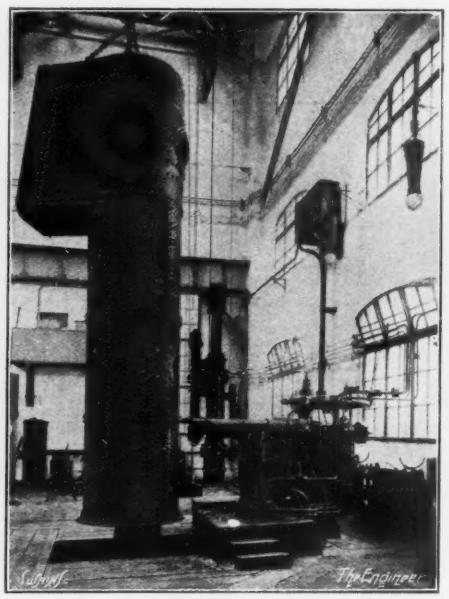


Fig. 8—HYDRAULIC RIVETTER

6½ horse-power; cross travel, 2½ horse-power; heavy hoist—25 tons—10 horse-power; and light hoist—5 tons—10 horse-power. The longitudinal travel is 175ft. per minute, and cross traverse 100ft. per minute. Two of these cranes are in the new boiler building bay, and one in each of the other two 60ft. bays of the shop. In the 30ft. bay, which contains a large proportion of the machinery, are two 5 ton overhead electric travelling cranes each fitted with four motors as under:—Travelling, 6½ horse-power; cross travel, 2½ horse-power; heavy hoist, 10 horse-power; and light hoist, 10 horse-power. The speed of these cranes is 300ft. per minute, and they are used for the conveyance of the heavy work from the cross-over rails to any machine where it may be required. All these cranes are by Craven Brothers. In addition to these electric cranes, there are several hydraulic wall cranes of various sizes. Six of these are by Cowans, Sheldon and Co., ranging from 30 cwt. to 40 cwt. capacity, and serve the different presses, whilst a number of wall jibs carry the portable hydraulic riveters, of which there are three. Column jibs are also provided for placing plates in the various machines.

The position of the gas producers is clearly shown on the plan, and a view of the plant is given in Fig. 1. A vertical boiler is employed to work the Roots blower which is used to obtain the necessary air pressure. There are four producers, each 8ft. diameter and 9ft. high, of the latest Wilson type, arranged with water seal for con-

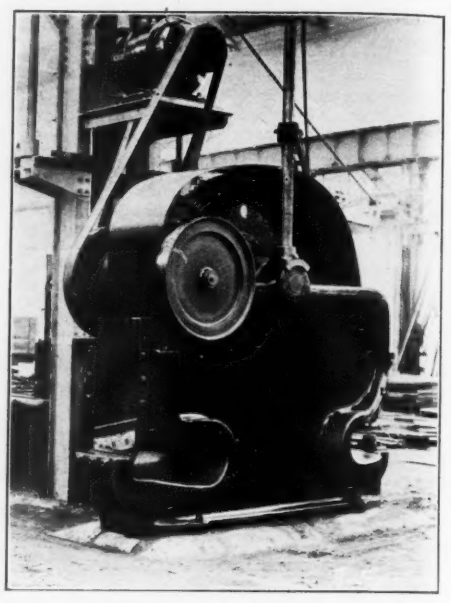


Fig. 9—PUNCHING AND SHEARING MACHINE

tinuous running; they are sunk below ground level to facilitate the unloading of the coal. Worked from three of the producers are four large gas furnaces so constructed that only the doors are in the building, the furnaces being outside. This arrangement ensures a considerable saving of floor space. One furnace is used solely for heating copper plates for flanging by hand. A tank 8ft. deep, sunk to floor level, is used for annealing after flanging.

There are three hydraulic flanging and stamping presses. The largest, which has a power of 300 tons, is shown in Fig. 10. In this press the greatest width between the columns is 10ft. 1in., and the space between the top of the table to the top casting when the table is fully down is 7ft. The main ram has a 3ft. 9in. stroke, and is fitted with an internal ram giving a power of

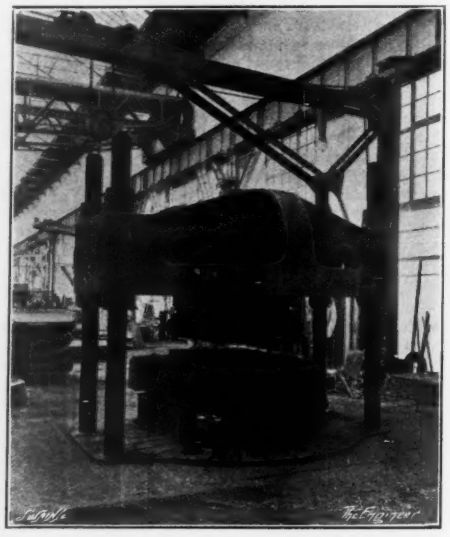


Fig. 10—300-TON HYDRAULIC PRESS

75 tons. The top casting can be lowered on the columns 3ft. 6in., and the bottom casting is fitted with four vicing rams and two rams for lifting the table rapidly to its work. The other two presses are of 230 and 100 tons pressure respectively.

The testing of the steaming qualities of boilers is carried out by the adoption of a system of induced draught, which has proved very satisfactory, the objectionable smoke and dirt generally associated with this work having been overcome. The boilers to be tested are placed by the overhead cranes on improvised bogies, an adjustable smoke-box is placed at the end of the tubes, the fan is started, and with this available draught any escape of smoke into the shop is prevented. By an arrangement of valves fixed on the wall, the boiler is filled with water at town pressure, after which the hydraulic test from the mains is applied at suitable pressure. If this test is satisfactorily passed, so much of the water is withdrawn

and fire applied for the final test. A view of the boiler testing shop is shown in Fig. 3.

A nest of four rope-driven stay tapping machines, one of which is shown in Fig. 7, has been installed close to the place where the boiler arrives for this operation. Two of these machines can work at the sides or ends of the fire-box simultaneously. These tappers occupy a position adjacent to the copper stay-making department, the equipment of which comprises four of Messrs. Herbert's latest machines for quick repetition stay work, also various other machines used in the making of stays.

The position of the mangling rollers and the marking-off tables—see Fig. 4—with regard to the various processes of machining can be seen from the plan, so also can the positions of the drilling, slotting, planing, sawing and milling machines. The western 60ft. bay is mainly devoted to tender tank building, and the same order has been followed here in laying down the machinery as in the boiler shop. The angle smiths, occupying a space 60ft. by 40ft., are provided with a set of angle-bending rollers, hydraulic press, and hydraulic bar-straightening machine. The northern half of the bay under notice is reserved for heavy boiler repairs, and provides accommodation for thirty boilers of the largest type.

The shop has been so arranged that the materials entering into the construction of a boiler pass from machine to machine through the various processes of flanging, levelling, drilling, shearing, planing, rolling and riveting practically in one direction until they arrive at the south end of the east bay, a riveted boiler. Materials are delivered on a cross road in the centre of the east bay, unloaded there and the wagons pass out at the west side of the shop. Thus the maximum of output at the minimum of expenditure of time and labour are secured.

The shop is lighted by 70 Gilbert's flame arc lamps of 1600 nominal candle-power, which are suspended below the girders carrying the overhead cranes and are arranged in circuits of five lamps. On each of the 75 columns in the shop there are fixed connections for the compressed air supply to the various portable pneumatic tools, as well as a two-way socket to which portable lamps and portable motors may be connected for use inside the boilers. On 19 of the columns 32 candle-power incandescent lamps are fixed for use at night-time.

The stores, from which the various classes of material necessary for boiler building are obtained, are important features, and upon them much depends to ensure expedition in working. Much care has been exercised in determining the positions of the stores and their contiguity to the shop, and also the manner of storing materials with regard to the various stages of their employment in the work of construction.

The stores are, as will be seen from the plan, at the east side of the boiler shop, and contain, from north to south, tube shed, 144ft. by 20ft., plate shed 108ft. by 60ft., divided into two bays of 30ft. each. The eastern bay containing a 3-ton overhead electric crane, and angle and bar shed, 36ft. by 20ft. In the immediate vicinity of the latter shed, and to the south of it, is a general stores warehouse, 100ft. by 40ft., which also contains a 3-ton overhead electric crane.

We are enabled by the courtesy of Mr. V. L. Raven, M. Inst. C.E., the chief mechanical engineer of the North-Eastern Railway, to publish the foregoing illustrations and particulars, and also the series of four views of the boiler shop, which are reproduced on page 644.

ANNUAL REPORT OF SECRETARY OF NAVY, UNITED STATES.

PROBABLY nothing in the annual report of the Secretary of the Navy, Mr. Meyer, will please the British public more than what he has to say regarding shipyard administration in England. Mr. Meyer has been convinced for some time that there was something wrong in the management of the American navy yards; at least, that there was considerable room for improvement. He says:—

I found in England, at the works of Messrs. Vickers Limited at Barrow-in-Furness, a most efficient, simple system of management. Briefly, it may be said that this establishment has an engineering department and a shipyard department, with an electrical division under the engine department. They arrange, in the larger jobs, for the orderly passage of the separate parts from one shop to another, instruct the workmen how to work most efficiently, and follow the separate operations, by means of a corps of skilled progress men, until the assembly is completed. In a general way the work is thoroughly systematised on common-sense principles, but no attempt is made to go into the forecasting of minute details. In consequence the extra cost of elaborate planning is avoided. The greatest percentage of increased efficiency seems to have been attained by broad effects in systematisation and in securing the cheerful co-operation of the workmen toward best results through proper recognition of their initiative and more efficient effort. The management at Vickers' is thoroughly convinced that excessive prevision of detail does not pay. The company is confirmed by its experience at one of its plants at Erith, where for between three and four years there had been installed one of the most elaborate of the scientific management systems with unsatisfactory results. At this point the individuals responsible for the introduction of this system were discharged and the system in use at Barrow-in-Furness was introduced. Within six months after this time the plant ceased to lose money, and within a year was making money under the simpler management.

I am entirely convinced, from study of the different systems of so-called scientific management and close examination of the system employed at the Vickers plant in Barrow-in-Furness, that the main principles and practice of the best management are employed at the Vickers plant, with resulting increased efficiency and economy. The preliminary report received from two expert engineer officers, whom I sent over to study and bring back the details of the Vickers system, confirms me in the impressions I have given above. The system and methods described appear to be suitable to our needs, and bear the birthmarks of common sense and simplicity of detail, reducing paper work to a minimum, starting work phenomenally quickly after orders received, following up work constantly and intelligently, thus securing results and correct costs.

Observation on this visit and consultation with officials of Government and private yards convince me beyond doubt that the two-division organisation now employed in our yards—namely, hull and machinery divisions, each presided over by an expert in that branch—is logical and entirely correct. I do not propose to make any change in this regard. The experience developed under the present organisation in our yards and the study of the best examples of modern management in this country convince me that still greater co-ordination of divisions is desirable, and that it is advisable to establish, under the Navy Department in Washington, a central planning office for all of the navy yards, and in each navy yard some system of central planning which will better co-ordinate the two divisions.

Strange as it may seem at first blush, this improvement in co-ordination in navy yard work is pointed out by Secretary Meyer as the very germ that brought about the radical improvements in the target practice of American men-of-war when applied to gunnery.

The Secretary of the Navy points with considerable pride to economies effected in the naval service by a more efficient and direct administration of the various departmental divisions. These savings represent some hundreds of thousands annually, and will probably lead to Congressional confirmation of the rather revolutionary changes which Mr. Meyer has been testing preparatory to seeking legislative authority for their continuance. He has cut the troublesome tangle of red tape in a good many directions and has produced results which were quite impossible under the older and more cumbersome system of administration in some of the Bureaus. The keynote of the Secretary's policy is business efficiency, and he believes that the fleet should be maintained in readiness at all times, and to this end he expects up-to-dateness and promptness in every branch of the Department and the executive navy yards. To this end, much to the dismay of some politicians and local business interests, Mr. Meyer strongly urges the abolition of some of the American navy yards, and proposes to establish new naval bases better suited to take advantage of the strategic changes that will be made upon the completion of the Panama Canal. Upon this point, Secretary Meyer has this to say:—

The Panama Canal will in effect be a naval base, since the docking and repair facilities to be provided there for commercial vessels will meet our naval requirements in time of war. The Panama Canal . . . . will become a part of our coast line, and is destined to become the most important strategical point in the Western Hemisphere, and makes a Caribbean naval base with adequate docking and repair facilities absolutely necessary. The best location for this station is Guantanamo Bay, Cuba, which we now hold. Assuming that we will continue to maintain an efficient fleet, this base not only will enable us to control the Caribbean with all of its lines of approach to the canal, but, with a torpedo base at Key West, will render the Gulf of Mexico immune from attack. If we were freshly confronted with the duty of locating and building the naval stations required in the Atlantic, without regard to existing stations, the interests of the nation and the navy would be best served by the establishment of one first-class naval station on the coast north of the Delaware, equipped for docking, repairing, and provisioning at least half of the entire fleet, and one station of the same capacity at Norfolk, Chesapeake Bay. This would be supplemented by a fleet *rendezvous* at Guantanamo with sufficient docking and repairing facilities to enable the fleet to maintain itself in that vicinity for considerable periods, but not for extensive repairs; a large torpedo boat base at Charleston, South Carolina; a torpedo and submarine boat base at Key West, and a station for the large reserve fleet at Philadelphia.

If these recommendations are carried into effect, they will undoubtedly call for serious consideration of modifications of the existing military defences of the British interests in the West Indies.

Of gunnery the Secretary has this to say:

There has been a marked advance in gunnery in the past twelve months, the principal features being that the ships hold an actual battle practice twice yearly, and are required to keep the *personnel* and *matériel* at such a high state of efficiency that they may be called upon to hold these practices at an hour's notice.

The ships are required to fire in rough weather under varying unfavourable conditions, so that the problems they meet in action will not be any more difficult than those worked out at the regular yearly battle practices.

Accuracy in marksmanship has increased by a large per cent., due to the successful methods of training, which keep both officers and men in enthusiastic competition.

Under the Bureau of Ordnance, the annual report gives a good deal of suggestive information. The new battleships New York and Texas are to carry 14in. guns of 45 calibres length. These weapons are well under way, and the type gun has proved both structurally and ballistically eminently satisfactory. With some modifications in their breech mechanisms, the anti-torpedo guns for the New York and Texas, and the two battleships last authorised, numbers 36 and 37, will be the standard 5in. weapons of 51 calibres. For the "destroyers" a new 4in. 50-calibre weapon has been designed. The service 3in. 50-calibre guns have an improved type of excentric breech mechanism, which, it is said, will remove all possibility of premature discharge through improper manipulation or breaking of parts. The report states:—

Valuable data on the subject of erosion have been collected, but, while the causes thereof are now well understood, and the amount that will result from the firing of a given number of rounds can be predicted with accuracy, no considerable progress has been made toward reducing or eliminating this source of deterioration of guns, although experiments have been made along a number of different lines.

In connection with the matter of turrets, ammunition supply, &c., we are told that the new turrets will not require projecting sighting hoods, and their arrangement will be such as to reduce the number of men required for their operation. Further, we are told:—

The matter of ammunition supply to turrets has been much discussed of late, and in many ships the hand passing of powder, stowage of shell in turrets, and hand loading have been advocated and successfully practised. There seems to be no doubt that powder can be passed up by hand, and that so long as the supply of shell in the turret is not exhausted a rapidity of fire can be maintained which is at least equal to that attained when ammunition is mechanically supplied. The Bureau believes, however, that the true measure of a turret's efficiency is the average rate of fire it can maintain until its ammunition supply is exhausted rather than the rate it can maintain during the short or long period of time required to exhaust the supply of shell stowed in the turret, and that false ideas of the desirability of certain features of the so-called hand-loading systems have been engendered by the excellent results attained at target practice by means of them.

The smokeless powder for the navy is declared to be of such excellence that no marked advance in quality can possibly be reported for the past year. The Bureau holds that the method of perforating the grains, which was criticised somewhat severely by "a well-known American" residing abroad, is recognised as one of the chief merits of the United States navy powder. The "stabiliser," now incorporated in the navy powder, is said to act "not only in its designed capacity, but is an efficient and automatic detector of irregularities in manufacture," thus ensuring the making of a better propellent. Experiments have been made to reduce erosion of guns by mingling ozokorite and graphite with the service powder, but nothing conclusive has yet been ascertained.

The situation as regards armour-piercing shells has not materially improved during the past year. Only three firms are engaged in manufacturing these projectiles, and deliveries are slow because of frequent ballistic failures. The Bureau of Ordnance has revised its specifications for armour-piercing projectiles, without any depreciation in quality, hoping thus to facilitate the wider manufacture and prompter delivery of the shells.

It is stated that in thick armour no marked improvement has been made during the past twelve months. Plates of satisfactory quality have been produced, and ballistic failures have been very few, but the Bureau does not consider itself warranted in increasing the severity of the tests. On the other hand, there has been a steady, though not remarkable, improvement in the quality of thin plates made of special-treatment steels. It is said that the experimental firings against the old ram Katahdin and the obsolete battleship San Marcos have proved very instructive in the matter of armour, and were the means of furnishing information of value to be applied in the designing of later vessels. One thing proved is the important fact that a projectile, while in flight, is at all times tangent to the trajectory, and another truth disclosed was that the penetrative effects of projectiles at battle ranges on modern armour are in accordance with previously calculated data. These two points have been provocative of endless discussion.

Two new types of long range high-speed torpedoes are under construction, and the Navy Department entertains high hopes of securing a weapon which will be effective at ranges considerably in excess of those now realised.

The Bureau of Ordnance has designed and tested a type of aeroplane gun which has given excellent results; but the officials seem still to be doubtful whether weapons of that type will ever be demanded by service conditions.

Regarding the work of the Bureau of Steam Engineering, Secretary Meyer reports at some length. We give several extracts below:—

Economies of considerable magnitude have been effected through co-operation of the Fleet and the Bureau in the management of machinery and the method of carrying out repairs. It is not possible to state with any degree of accuracy what these economies have amounted to, but the fact that we are now maintaining a fleet about 20 per cent. larger than the one in commission two years ago, and are doing it with an appropriation under this Bureau of 400,000 dols. less, is the best evidence of what has been accomplished.

The Bureau is now making inspection, so far as practicable, at the place of manufacture. This obviates delays resulting from rejection of material at the place of delivery, and consequent loss of time to replace the rejected material, and should result eventually in reduced price of material, because the manufacturers are thereby relieved from the expense of unnecessary freight charges. . . .

The main engines as installed in the battleships Louisiana and Virginia were fitted to turn inboard when going ahead. This direction of rotation of the propellers was found seriously to handicap the handling of the vessels, and the engines have accordingly been changed to turn in the other direction. The work was done at the Norfolk Navy Yard, and has been satisfactory in every respect, the cost being much less than estimated by the company which built the engines. . . .

Under the spur of steaming competitions, propellers which are more efficient at the cruising speeds have been fitted on the Kansas and North Carolina, and are to be installed on the Mississippi and Vermont. As soon as accurate data of the efficiency of existing propellers under service conditions can be obtained, it is intended further to improve the efficiency of the fleet as a whole by replacing those propellers which are least efficient at cruising speeds. . . .

There is a continual improvement in the economy of coal consumption in the vessels of the service, due principally to the steaming competition. In the direction of this economy, the evaporators of many of the vessels have been converted to double effect, with an improvement in efficiency of from 35 to 40 per cent. . . .

To test the reliability of the reciprocating engine in its present development under conditions that might obtain in time of war, the Delaware, in April, immediately upon her return to Boston from an extended South American cruise, was subjected to a surprise full-power run of 24 hours. Prior to this trial she was in port only 22½ hours for the purpose of coaling, during which time no examination or adjustment was made about her main engines. Her average speed for the 24 hours' trial, burning coal alone, was a little better than her contract speed. There was no derangement of the main engines or auxiliaries during the trial or during the standardisation runs which followed. Subsequent to these trials the Delaware steamed from New York to England, remained there 12 days, and returned to Boston, having completed the round trip without taking aboard any fuel during the trip and with 600 tons of coal left in her bunkers at the conclusion of the trip. . . .

In the face of an almost universal adoption of the turbine for battleship propelling machinery by the nations of the world, the Department has, in the recent battleships, beginning with the New York and Texas, abandoned the turbine in favour of reciprocating engines. This decision was arrived at after an extensive investigation, including the comparative trials of the two types of machinery, in the scout cruisers Birmingham, Chester, and Salem, and in the battleships Delaware and North Dakota, which render available more exact data on the subject than is available to any other Government. It is found that the reciprocating engine is about 30 per cent. more economical at cruising speed than the turbine and of about the same economy at high speeds.

In the field of engineering perhaps one of the longest strides toward economy was made in providing an incentive to the engineering force in the direction of fuel and lubricating oil savings. The yearly competitive steaming tests have been remarkably successful and, quite apart from direct material economies, have resulted in a far higher standard of efficiency than had prevailed previously. The men of the various ships are very keen in their struggles to keep their vessels up to the top requirements and yet to minimise the expenditures of coal and oil.

The Secretary of the Navy has outlined a building pro-

gramme, and gives his reasons for the various types of vessels that should be added sooner or later to the active list of the service:—

The Department submits, in its estimates to Congress, provisions for two battleships and two colliers. In making this recommendation programme, it adheres to what has been regarded as a necessary policy for years past of building two new battleships each year to prevent a decrease in the effective strength of our armoured fleet. . . .

The policy of replacing our old battleships at the rate of 2 each year, if continued indefinitely, will give us eventually, though not as soon as is to be desired, a total of 40 battleships, of which 20 less than 10 years old would constitute the first line and the remaining 20 between 10 and 20 years old would be available for the second line.

A total of 40 battleships, with a proportional number of other fighting and auxiliary vessels, is the least that will place our country on a safe basis in its relations with other world Powers. While at least two other Powers have more ambitious building plans, it is believed that if we maintain an efficient fleet of the size above mentioned we will be safe from attack and that our country will be free to work out its destiny in peace and without hindrance. The recommendation for a continuing policy which will give us the fleet desired is made with a due regard for the almost world-wide movement for the settlement of international disputes by arbitration, in which movement our own country has taken a foremost part. History of all times, including the present, shows the futility and danger of trusting to the good will and fair dealing, or even to the most solemnly binding treaties between nations for the protection of a nation's sovereign rights and interests, and without doubt, the time is remote when a comparatively unarmed and helpless nation may be reasonably safe from attack by ambitious, well-armed Powers, especially in a commercial age such as the present. The economical system of a great commercial nation is so delicately balanced that even a threat of war is very disturbing and harmful, while a war with any other great Power would cause incalculable damage. To avoid war and ensure peace we should be prepared for war. . . .

The navy is very deficient in certain classes of vessels required for the maintenance and protection of the battle fleet. These vessels are battleship-cruisers, scouts, destroyers, submarines, repair, supply, fuel, ammunition, and hospital ships, and tenders to torpedo vessels. A number of gunboats, river gunboats, and tugs also are required for the routine duties of peace as well as war. The number of such vessels, except gunboats and tugs, should be proportioned to the number of battleships; for example, there should be four destroyers for each battleship, one scout for each battleship, one repair ship for each squadron of eight battleships, &c.

The battleship-cruiser is a modern development in foreign navies, notably the British, German, and Japanese. It is a vessel equal in size to the largest battleship and carries a battleship's battery, but its armour protection is sacrificed for great speed. It is capable of overtaking and destroying all vessels other than the most powerful battleships.

The Department, while recognising the value of this new type of vessel, has not heretofore recommended its adoption in our navy owing to our comparatively inferior strength in battleships of the Dreadnought and super-Dreadnought type, and to the necessity for remedying this deficiency before taking steps to obtain battleship-cruisers which can not be regarded as equal to a battleship of the best type in general usefulness. The inclusion of one such vessel in this year's building programme is most desirable, but it should be authorised in addition to the two battleships needed to maintain our present battleship strength.

The enlisted *personnel* of the United States Navy numbers, at present, 46,759. Of this total enlisted force, 89.79 per cent. are native born, 6.41 per cent. are naturalised, giving a total percentage of citizenship amounting to 96.20 per cent. This information will dissipate some of the oft-repeated assertions that the United States navy is very largely recruited from aliens.

RECENT GREAT WESTERN EXPRESS WORK.

The following notes present some idea of the work—principally of the "Queen" class—on the heaviest expresses of the Great Western Railway. There are ten engines in the "Queen" class, and all are of the latest four-cylinder 4–6–0 type, built at Swindon, all being fitted with superheaters. On other railways the adoption of the superheater has been accompanied by a considerable reduction in boiler pressure, and also by larger cylinder bore, but on the Great Western the high pressure of 225 lb. per square inch is still maintained, in conjunction with superheating, for express work, the cylinders being practically of the same size as formerly. The boilers of the "Queen" class have been fitted with the top feed—now the standard practice on the Great Western. The feed-water is sprayed through the steam space, and is thus raised to boiler temperature before falling on the water.

For the heaviest express traffic the Great Western now possesses ninety six-coupled engines, forty-one having four cylinders, each 14½in. by 26in., the other forty-nine having two cylinders, each 18in. by 30in. The boiler and wheel dimensions are identical in both classes, the coupled wheels being 6ft. 8½in. in diameter. In time all will, we understand, be provided with the Swindon superheater, which has already been fitted to a considerable number.

The first four runs, reported on below, deal with the working of the expresses leaving Paddington at 10.30 a.m., 11.50 a.m., and 3.30 p.m., which are timed to reach Exeter, 173 miles 53 chains, in 180 mins., averaging 57.8 miles an hour over a hard road, with curve slacks to 30 miles per hour at Reading, Westbury, and Frome.

On the 10.30 a.m. Limited, No. 4033 (Queen Charlotte) hauled eleven coaches, weighing 370 tons full. A fairly strong side wind was blowing. The start was not good, as the first nine miles took 13 mins., and post 12 was passed before reaching a rate of 60. After Southall a rate of 65 is necessary to pass Reading to time, but 25 miles of level to post 35 occupied 23¾ mins., the maximum speed being 64. The train slackened through Reading 1¾ mins. late, the 36 miles having taken 38¾ mins. On the rise of 30 miles to Bedwyn—averaging 1 in 477—the speed varied between 55.3 and 58.1. Then two miles at 180 brought it to 48.6, and the final mile at 144 to a minimum of 46.4. Savernake summit, 70 miles, was passed in 76¾ mins., that is 3¼ mins. late; but some time was recovered by running the next 18 miles of easy descent in 16 mins. 8 secs., without exceeding 77.4 miles per hour. The train slackened through Westbury, 95⅛ miles, in 99¼ mins., averaging 57.5. Two coaches were slipped, which reduced the load to 310 tons. The Witham Bank of 7¼ miles—which has to be taken from the slack at Frome—was climbed in 8 mins. 56 secs., the speed rising to 52.3 on gradients of 1 in 216, and ending at a minimum of 47.8 on the last half-mile of 1 in 107. The next 34¼ miles—commencing with the descent of the Bruton Bank for 6¾ miles, and undulating afterwards—were run in 31¾ mins.; and the train passed Taunton, 142⅞ miles, in 147¼ mins. The Wellington Bank of 10⅞ miles was climbed in 13 mins. 20 secs. On gradients of 1 in 209 and 1 in 163 the speed did not fall below 51.4, but the last 3 miles of 1 in 90 and 1 in 81 reduced it to 38.7. Without exceeding 74.8, the descent of 20 miles to Exeter was made in 18¼ mins., the slip coaches stopping in 179 mins. from Paddington, having covered the distance at an average rate of 58.1 miles per hour.

On the 11.50 a.m. a load of thirteen coaches, weighing 425 tons full, was hauled by No. 4034 (Queen Adelaide). A signal check to 10 miles an hour a mile after starting caused a loss of 2½ mins., and the train was 4 mins. late on passing Southall, 9 miles, in 15 mins. Twenty miles to post 35 were then run at an average of 64.8 miles per hour, and Reading was passed slowly in 40½ mins. On the rise to Savernake speed varied between 56 and 61 miles per hour. On the 1 in 180 bank beyond Bedwyn the speed fell to 49.5, and on the last mile of 1 in 144 to 45 miles per hour. Savernake was passed in 77 mins. 50 secs. Twenty miles of easy descent were then run in 16 mins. 23 secs. at a maximum of 79.1 miles per hour, and the train slackened through Westbury in 100 mins. 5 secs., having averaged 57.1 miles per hour. One coach was slipped, leaving 390 tons for Taunton. As the Frome curve is only 5¾ miles farther, no high speed is possible for some miles. The Witham Bank was climbed in 9 mins. In two miles from the Frome slack the speed was 50 miles per hour, which was maintained for three miles, the minimum at the summit being 44.5. The next 29½ miles were covered in 26½ mins. at a maximum of 78.3 on the Bruton Bank. Cogload Box, 137¾ miles, was passed in 142 mins. 40 secs., and after a slight check the slip coaches stopped at Taunton half a minute early in 148 mins. 25 secs., this giving an average speed of 57.8 miles per hour. The 128¾ miles from Southall to Cogload were run in 127¾ mins.—that is, 4¼ mins. less than the booked time.

On another occasion the 11.50 a.m. consisted of fifteen eight-wheeled coaches, making a full load of 470 tons. The engine was No. 4033 (Queen Victoria). The first nine miles took only 12 mins. 40 secs., and the 25 miles to post 35 were run in 24 mins., it being good work to slacken through Reading in 38 mins. 40 secs. with this huge load. The observance of the usual slack caused the five miles to post 40 to occupy 7¼ mins. The rise to Bedwyn was begun at a speed of 59, but the train was stopped at post 52¾. This start-to-stop run had taken 58½ mins., and the average was 54.1 miles per hour, in spite of the Reading slack. After a stop of 1½ mins., the 17¼ miles' rise to Savernake took 24 mins., the minimum at the summit being 39.1 miles per hour. The next 67¾ miles to Cogload Junction were covered in 68 mins. 7 secs., which was 2¼ mins. less than booked time, with a load of 440 tons after slipping the Westbury coach. The Witham Bank was climbed in 9 mins. 25 secs. at a minimum of 42.8 miles per hour. Before Taunton a signal check caused 7 mins. to be taken for five miles, thus handicapping the engine for the Wellington Bank, which was climbed in 14 min. 37 secs. with a 360-ton load, three coaches having been slipped at Taunton. Speed rose to 52.9 on the rise of 1 in 209, but fell to 30 at the summit. The descent of 20 miles to Exeter took 19½ mins. In all reasonable probability Taunton would have been passed to time had not the unfortunate stop occurred.

On the 3.30 p.m. train the two-cylinder engine No. 2923 (St. George) hauled twelve coaches weighing 365 tons. The first nine miles took 12¾ mins. For 17 miles to post 32 the speed did not fall below 67.9 miles per hour, and for twelve consecutive miles on the level it was maintained at 70.6. Reading, 36 miles, was passed slowly in 36 mins. 38 secs. On the rise to Savernake the speed varied from 56.2 to 60 miles per hour, while on the last mile at 144 the minimum was as high as 51.7. The summit, 70 miles, was passed in 74 mins. 10 secs., and without exceeding 75 on the descent the train slackened through Westbury in 97 mins. 10 secs., the run having averaged 59.1 miles per hour. Two coaches were slipped, thus leaving 310 tons. The Witham Bank occupied 8 mins. 47 secs. Until the last 2½ miles to the summit the speed had not dropped below 52.9 miles per hour, but the minimum was 48.9. Being to time, the descent of the Bruton Bank was made, with brakes on, at a maximum of 69.2, and 34¼ miles to Taunton were taken easily in 33½ mins. Taunton was passed 2½ mins. early in 146½ mins., this representing an average of 58.4. Two more coaches were slipped, leaving 255 tons, with which load the Wellington Bank was climbed in the quick time of 12 mins. 21 secs. for the 10⅞ miles. The first five miles were run at over 60 miles per hour, two miles at 167 reduced speed to 56, and after the rise at 90 and 81 the minimum was 38.1. After a leisurely descent, Exeter was reached in 178¾ mins. at an average of 58.2.

One of the hardest up trains to work from Exeter to Paddington is the 12.5 p.m., which is allowed 185 mins., giving an average speed of 56.3 miles per hour. The load is always heavy, and in the first 103½ miles there are only 23 miles of really easy running.

On one occasion the train consisted of twelve coaches, all modern stock, weighing 405 tons full. The engine was No. 2905, a two-cylinder 4–6–0 using superheated steam. The 20 miles' rise from Exeter occupied 26¾ mins. The first three miles took 6 mins. 34 secs., by which time speed was 48 miles per hour on a short rise of 1 in 207. On the 1 in 440 it rose to 56.2, falling to 47.3 after two miles at 1 in 154. The final 2½ miles of 1 in 115 were begun at 50.7 and ended at 36.5. The 11 mile descent to Taunton took 9¼ mins. at a maximum of 78.9 miles per hour, and the Cogload slack reduced speed from 70.6 to 50. The next 22¼ miles—mostly undulating—were run in 22½ mins., the train passing Castle Cary, 58½ miles, in 62¾ mins. Here commences the Bruton Bank of 6¾ miles, which occupied 8 mins. 21 secs. On the easier slopes of 1 in 143, 1 in 358, and 1 in 163 for two miles the speed fell from 62 to 56 miles per hour; on the next four mostly at 1 in 98 it dropped to 45, while on the final rise of 1 in 81 the minimum was 32.8. After a cautious descent of the Witham Bank came the slacks to 30 miles per hour through Frome and Westbury, the 78 miles to the latter having taken 86¾ mins. At mile-post 88 a rise of 18 miles is begun, the first six at 1 in 222, on which the speed fell from 61 to 50. On the succeeding easier gradients of 1 in 400 to 1 in 500 the speed rose to 60, and on the last six miles—mostly steeper than 1 in 300, ending with a mile at 1 in 153—the rate fell from 58 to 53.5 miles per hour. The whole climb of 18 miles took only 19 mins. 8 secs., which is remarkably good work. Savernake summit, 103½ miles, was passed in 114¾ mins. On the falling gradients 30 miles were run in 25 mins. 49 secs., the average being 69.6 miles per hour. The first 136 miles occupied 143 mins. 5 secs., after which the Reading slack caused 5 miles to take 8 mins. After rapid acceleration, 22 miles of level were run at an average of 67.2 miles per hour, the speed rising to 70. On passing mile-post 2 there remained 5¼ mins., but the train was stopped dead half a mile from Paddington. The 173¼ miles to this point had taken 182¾ mins., giving an average of 56.8 miles per hour from start to stop. Even after the delay, Paddington was reached only a minute late.

Over the same route from Taunton, No. 4040 (Queen Boadicea) worked the 4.10 p.m. express, booked to Paddington at an average of 55.3 miles per hour. The load was nine coaches, weighing 285 tons. The first 27¼ miles were run in 30¼ mins. Then the Bruton Bank of 6¾ miles was climbed in 8 mins. 9 secs. It was begun at 61, and after four miles at 98 and 81 the minimum was 36.5 miles per hour. After the usual slacks through Frome and Westbury the speed rose to 61, and fell to 46.1 after six miles at 1 in 222. On the easier up gradients the speed recovered to 60, falling to 56 miles per hour at the summit. The 18 miles' rise took 19¼ minutes.

Savernake, 72¾ miles, was passed in 80¼ mins., and 30 miles of falling gradient were run at an average of 70.5 miles per hour. The train slackened through Reading, 107 miles in 110 mins. 55 secs., which was 5 mins. under booked time. So far the average speed was 58 miles per hour. On the level towards Paddington a rate of 67.5 was maintained until a check near Taplow brought speed down to 5 miles an hour. The 118½ miles to Maidenhead were covered in 122 mins. 55 secs.

After the check the driver did not hurry, the train reaching Paddington 2 mins. under booked time in 153 mins. 4 secs. for the 143 miles, averaging 56 miles an hour.

The maximum speeds in the first two runs were rather higher than usual. On these fast trains booked at 57.8 time has been kept throughout the run—with a load of 290 tons at starting—without exceeding a rate of 69.2; and a two-cylinder engine hauling 440 tons averaged 59.1 to Westbury without exceeding 70.6

Of late the two-cylinder engines have not worked the fastest express traffic to the West as much as formerly. It will be remembered that both two and four-cylinder engines exert a draw-bar pull of 2½ tons at 70 miles an hour, and that the latter are slightly more powerful and smoother riding.

The weights given as representing train loads are exclusive of engine weight.

THE CHOICE OF MOTIVE POWER.

By W. O. HORSNAILL, A.M.I. Mech. E., A.M.I.E.E.

THOSE who have to decide upon the best type of motive power under certain conditions are often faced by a difficult problem for which the solution demands financial knowledge as well as engineering experience. Such problems range from the isolated machine only used for a few hours during the twelve months up to a continuous demand for power night and day throughout the year, and it is proposed in this article to set forth the items bearing upon the cost of alternative means of developing power, together with approximate figures and general rules for their correct estimation under any conditions between these limits.

The items which make up the total cost of producing power may be classified under the two following headings:—(*a*) Standing charges; (*b*) Running costs; the former being independent of the load factor, whilst the latter vary with the hours of work and the average demand.

Before the question of motive power can be adequately considered, it is necessary to know the maximum power required, the number of hours worked throughout the year, and the average power demanded during the working hours. Having settled upon these factors, a basis of comparison for different sources of power must be decided upon, and for this purpose the total annual expenditure will be found more convenient than the cost per horse-power or horse-power hour.

We will now consider the two classes of cost items under their respective headings, assuming the sources of power to consist of steam, gas, oil, and electricity from a public supply.

(*a*) *Standing charges.*—These include the following items: Interest on capital outlay, depreciation and repairs, space, insurance and inspection.

Interest on capital is often taken at 5 per cent., but it is doubtful whether this figure is high enough. In view of the interest paid on debentures and bankers' loans, 6 per cent. would appear to be a more suitable allowance, excepting on very large amounts.

In estimating the total capital outlay great care must be taken to include building work, foundations, water supply, drainage, facilities for receiving fuel, &c. Also any possible outlay to prevent causing a nuisance. For instance, purification apparatus may be needed for gas producer effluent or special silencing appliances for the exhausts.

In certain cases, steam boilers, gas producers, and engines must be duplicated so as to allow of cleaning and repairs without shutting down the factory. Such conditions obtain in

electric generating stations, waterworks, and some industries. In other instances, although spare boilers or producers are needed, one engine will be sufficient, as arrangements can be made to overhaul during holidays. These features do not extend to electric motors which are now very reliable, whilst by keeping spare parts, repairs can be quickly effected. Moreover, the power is cut up into sections with possibly a motor to each machine, hence a breakdown only entails a minor stoppage.

Another important feature affecting the capital outlay is the reserve power in difierent prime movers. A steam engine is often capable of exerting double its rated power, whilst the electric motor will carry heavy overloads for short periods. On the other hand, gas and oil engines will stop altogether if the rated power be exceeded by, perhaps, 10 per cent., hence larger engines are needed where the maximum power is only demanded for an occasional few minutes.

Then again, the cost of transmission gear enters into any comparison between engines and electric motors, as the latter will probably be direct-coupled or belted to the separate machines, whereas the installation of an engine for power purposes involves either a generator with electric transmission or lines of shafting with rope and belt drives.

Depreciation and repairs for estimation purposes are often combined in one item, with an allowance assumed to be sufficient for maintaining the plant in working order. To enable a correct percentage for depreciation to be decided upon, it is necessary to consider the useful life of the plant in question and its residual value. The estimation of these factors is a very difficult matter. Take, for instance, a steam boiler, which, with careful treatment, should last for ten years without any considerable reduction in working pressure. At the end of this period a boiler in fair condition may still be saleable for the supply of steam at a lower pressure. On this basis 10 per cent. would be too high an allowance, the correct figure being probably about 6 per cent. In any case, a boiler wears out completely, so far as its original purpose is concerned, and it must be entirely replaced. On the other hand, an engine, whether for steam, gas, or oil, will last an indefinite time under careful usage, as all the parts subject to wear are renewable; hence a very low figure for depreciation would seem to be adequate. Also a similar feature pertains to an electric motor, the carcase of which should be almost everlasting.

We have to bear in mind, however, that power plant is generally replaced, not because it is worn out, but owing to the advent of more efficient apparatus or the need for more power. If it be a question of installing more up-to-date plant, the chances are that the old stuff, having become obsolete, will only have a residual value of scrap metal, and even when new motive power is contemplated owing to an increased demand, the displaced plant will probably be out of date, unless the change takes place within the first year or two of its life.

In view of this liability to obsolescence, which is likely to obtain in future to an even greater degree than it has done in the past, a life of twenty years for power plant would appear to be an extreme limit, with a residual value of scrap metal at the end of it. This comparatively long life may be applied to electric motors, but ten years is a long enough period upon which to base a depreciation charge upon steam, gas, or oil plant. Added to this charge will be an allowance for repairs. This addition varies greatly with the type of plant, and depends to some extent upon the useful estimated life, as the repairs over the first few years will not be so heavy as during the period of old age. As stated above a boiler should last for ten years without requiring any considerable repairs, hence 2 per cent. for this item should be an ample allowance. On the other hand, a fast running engine is certain to need renewals in addition to the annual overhaul, and 5 per cent. will not be too high a figure.

Electric motors with their accessories are rather uncertain as regards the cost of maintenance. A motor should run for twenty years without any renewals excepting for brushes and bearing bushes, but there is always the possibility of a breakdown owing to faulty insulation which may mean considerable expense. Then, again, the switch gear will involve certain renewals in the way of contacts, resistance coils, &c. To cover these renewals and the risk of insulation troubles, at least 2½ per cent. should be added to the charge for depreciation. These allowances are based on a working year of about 3000 hours, and in the case of motor switch gears it is assumed that starting only occurs three or four times a day. For continuous day and night work the additions for repairs must obviously be increased in proportion to the extra working hours, and special allowances must be made upon switches for crane or other motors which are frequently started.

Buildings and foundations pertain almost exclusively to steam, gas, or oil plant, extra housing being seldom needed for electric motors, whilst the cost of foundations for the latter is almost negligible. As regards depreciation it is wisest to base the allowance on a life of ten years, as when the motive power is replaced the buildings and foundations will probably have to be reconstructed. For so short a life the repairs should only amount to whatever painting may have to be done so that a very small allowance will be enough, say, 2 per cent. Occasionally it is necessary to compare the cost of new plant with existing steam or gas engines which are still serviceable for several years. In such cases the original allowance for depreciation may have already been sufficient to cover the first outlay, and it might therefore be proposed to ignore capital charges altogether. This course would give the old plant an undue advantage, as the original depreciation was obviously too high. The correct method is to estimate the remaining useful life and fix a new depreciation charge on the longer basis, thus giving a value, with allowances for interest and depreciation, for inclusion under standing charges.

Space.—The room occupied by steam or gas plant may be a very serious item where rents are high and space for extentions is limited. These conditions often obtain in factories situated in populous centres, and not only must an allowance be made to cover rent, rates, taxes, &c, but the question of interference with manufacturing operations should be considered. The cost of such interference can only be estimated especially in each case, no general rule being possible. In country factories, on the other hand, space costs very little, it is only a question of ground rent, rates, taxes, insurance, &c. When estimating the space needed, storage for coal or oil must not be overlooked. An oil engine takes up much less room than steam or gas plant, both as regards the engine and the storage of fuel, whilst electric motors can generally be so arranged as to occupy no appreciable useful space at all. It is now a common practice to insure all kinds of power plant, periodical inspection being the accompaniment of this system, and due allowance should be made for this item.

(*b*) *Running costs.*—These comprise:—Fuel or current, attendance, oil and stores, water, stoppages, supervision and office work, and the elimination of nuisances.

Fuel or current.—The cost of this item depends upon the quantity used and the price. In estimating the quantity from the working hours and the average load, it must always be remembered that steam plant is not nearly so efficient under ordinary working conditions as would appear from test figures, whereas gas and oil engines are much more satisfactory in this respect, and the cost of current for electric motors may be based on actual test results. An estimate is seldom needed for the consumption at full load; in fact, more often than otherwise, the power demanded varies between wide limits, consequently, the consumption of fuel or current on test at the average load, must be taken as a basis. For steam plant an addition of 50 per cent. to the test figure will not be too great an allowance for soot, scale, leaks, inferior coal, faulty firing, &c., whilst 25 per cent. may be added for gas, and 15 per cent. for oil engines. Another feature already alluded to is the maximum power available, the proportionate average load being thereby reduced for gas and oil engines, so that whilst the consumption at half load might be taken for steam plant, one-third or even one-quarter might be a proper figure upon which to base the cost of fuel for a gas or oil engine under a similar varying load. It need scarcely be stated that the auxiliary machinery such as feed pumps, coal conveyors, &c., must be allowed for in estimating the consumption of fuel.

Attendance.—This item is much more serious with steam plant than is the case for other types of motive power. Two men at least are needed to run boilers and engines of any considerable output, whilst extra labour is often entailed for handling the coal. Then a good deal of cleaning has to be done in connection with boilers, flues, economisers, &c., and overtime is involved for starting up in the morning and shutting down at night. For gas plant the reduction in labour is not so great as might be supposed, as a driver competent to attend to an engine of several hundred horse-power will not undertake the duty of serving the producer, although he may have ample time for this work. Such being the case, two men still have to be retained, and both must be on the spot all the time the plant is running. The driver will certainly "jib" at doing any other work, and the stoker is only able to fill up his spare time with duties which can be performed in the producer-house. Cleaning is not, however, such a big item, neither is the time taken to start up nearly so great as with steam plant, whilst any coal-handling can be done without additional labour. In this matter of attendance the oil engine shows up to great advantage, as one man can attend to comparatively large powers, and the extra time for starting up is only a matter of minutes. Still less attention is demanded by electric motors, in fact the amount is so small as to be negligible.

Oil and stores.—The chief consumption of lubricating oil in a steam, gas, or oil engine, occurs in the cylinders, as the oil used for this purpose cannot be recovered, whereas with modern systems of forced lubrication, the oil needed for other parts is pumped round the engine over and over again, only the small quantity wasted by leakage being actually consumed. The quantity of oil used for all purposes varies roughly as the number of cylinders, × the diameter × the stroke × the revolutions, and if the figure thus arrived at be divided by 100,000 the result will be the number of pints per hour.

$$\text{Or } \frac{N \times D \times S \times R}{100{,}000} = P$$

where N = number of cylinders, D = diameter (inches), S = stroke (inches), R = revolutions, and P = pints an hour.

For an engine of 10 horse-power this formula gives an oil consumption of about .25 pints, whilst a single cylinder engine developing 100 horse-power would require about 1.88 pints an hour. By this rule the amount of oil is considerable for low powers, whilst the consumption in large engines only forms a small item in the costs. This feature is amply supported by figures from tests and every day practice; but, of course, the amount of oil used varies between wide limits according to the design of the engine and the carefulness of the attendant. Our rule simply gives quantities which can be worked to with modern plant when carefully looked after.

A steam engine may generally be said to need less oil than a gas or oil engine of equal power, likewise a two-cycle or a two-cycle double-acting, gas or oil engine will have a lower consumption than the four-cycle type, but these features are automatically allowed for by the reduced dimensions of the cylinders.

Oil varies considerably in price, but a workable gas engine oil can be obtained for 2s. a gallon, and this figure may be taken as a basis for estimating the cost. Stores may conveniently be added to the cost of oil as a percentage, and an allowance of 10 per cent. for gas and oil engines should be enough; whilst 20 per cent. may be added for steam plant to cover gland packings, jointing materials, &c. The oil and stores needed for electric motors form so small an item that it is scarcely worth troubling about.

Water.—The amount of water used by a steam engine is supposed by many to be greater than the quantity needed for a gas engine. This is not necessarily the case if cooling towers or evaporative condensers be included in the steam equipment. Oil engines undoubtedly use less water than either; whilst electric motors need no water at all. In steam engines fitted with surface condensers the water used for generating steam passes round a closed circuit and only a small amount is lost by leakage. The main demand for water is for condensing the steam; but here, again, if water be scarce, cooling towers or evaporative condensers are resorted to, which allow of the water being used over and over again, the only waste being from evaporation. The latter may be taken at two-thirds of the steam condensed, the steam consumption being arrived at from test figures or engine makers' guarantees, by adding 50 per cent. to represent the consumption under every-day conditions.

Gas plant varies in water consumption between one gallon and five gallons per brake horse-power hour, and the only reliable method of estimating the quantity is to obtain a guarantee from the makers and add, say, 25 per cent., or to take test figures, if available, of the same make of plant under similar working conditions. As a rough figure, 2½ gallons per brake horse-power hour should be an ample allowance, excepting for certain makes, which appear to require an excessive quantity.

Occasionally the waste water from gas plant is purified and used over again, in which case the consumption is reduced to a negligible amount. This practice, however, involves especial apparatus, and would only be contemplated where there was a difficulty in getting rid of the discharged water. The water needed by an oil engine is confined to the evaporation of the jacket water from tanks or cooling towers. This is so small in amount that the cost is not worth going into, even when town water is used.

Stoppages.—Although this item appears to be foreign to our heading of running costs, it has an important bearing upon them. Gas, steam, and oil engines are unfortunately liable to unforseen stoppages even under careful treatment, and the results are more or less costly according to the nature of work and the duration of the stoppage. In certain industries, such as the generation of electric current for public supply, stand-by plant is always kept ready for immediate use, hence stoppages are of rare occurrence; also in large factories where electric driving is resorted to, a similar feature generally prevails. On the other hand, the smaller private power plants are seldom duplicated on account of the heavy capital charges thus incurred, consequently stoppages occasionally take place. The sudden cessation of work in a factory is a serious expense if prolonged for more than a few minutes, the cost being roughly in proportion to the selling value of the output of the machinery during the wasted time. In other cases external costs may be involved as might occur when unloading a grain cargo with elevator gear, the demurrage on such vessels being a considerable item.

There is little to choose between the best steam and gas plant as regards stoppages, and the liability is rather difficult to estimate, but in general, one working day a year should be an ample allowance. Oil engines, owing to the absence of boilers or producers, are less liable to stoppage, hence half a day a year should be sufficient to cover this risk. Electric motors, fed by public supply circuits, are now the most reliable means of developing power, and the risk of stoppage with the best apparatus under careful treatment is not worth taking account of.

Supervision and office expenses.—This item, although often overlooked, is of considerable importance in connection with steam, gas or oil plant, and a proper allowance should be made for it when comparing different methods of developing motive power. Supervision must be exercised by some one, part of whose time is thus occupied. In a large factory a competent engineer is generally employed to supervise the whole of the machinery, and a portion of his salary should be charged to power production. Then there is office accommodation to be allowed for, with a proportion of the cost of clerical work for correspondence and the payment of wages to engine drivers, stokers, &c., whilst stamps and stationery must also be included. The purchase of coal, oil, stores, &c., also involves a good deal of correspondence and other office work. Here again, oil engines involve less supervision and office work than steam or gas plant, whilst this item is a very small one indeed for electric motors.

The elimination of nuisances.—This feature may affect the running costs in the form of power or chemicals for purifying the waste water from gas plants, but more often it will be confined to apparatus involving capital charges only. An important feature bearing upon the cost of motive power, is the demand for heat in the form of hot air for warming or drying, and steam for boiling or other purposes. Brewing, washing, paper-making and some other industries require steam for boiling, heating and drying as well as for power, and provided that approximately all the exhaust steam from an engine can be utilised in this way, steam becomes very efficient.

The purposes above mentioned involve a supply of steam at from 5 lb. to 10 lb. pressure above the atmosphere, supplemented by much higher pressures for certain apparatus. This feature offers no difficulty, however, as the engine can work against 5 lb. to 10 lb. in the exhaust, whilst high-pressure steam is supplied direct from the boiler. Steam may also be generated by the heat in a gas or oil engine exhaust, the efficiency being further enhanced by utilising the hot jacket water for feeding the boiler. Still another method of utilising the waste heat from gas and oil engines consists in heating air direct instead of through the medium of steam, for drying or warming and ventilating on the "Plenum" system. Assuming a loss of 25 per cent. in the apparatus, 75 per cent. of the waste heat, referred to above, can be utilised, and the fuel consumption in a steam engine may be thus reduced by 40 to 50 per cent., whilst gas and oil engines would only require about two-thirds of the fuel needed where the exhaust and jacket-water heat is thrown away.

The difficulty is to use this heat continuously when the engines are running. This can only be done where the demand for heat greatly exceeds the supply, involving supplementary heating appliances. Such conditions obtain in certain industries, whilst some types of factory can use up all the waste heat from the power plant for warming the buildings during about seven months of the year. It must be borne in mind, however, in connection with warming that the economy is reduced in accordance with the annual period in use, also that unless all the heat can be used at the average load and on the mildest day when warming is needed, the saving will be still farther lessened. Supposing, for instance, that the waste heat from the engine under average load were enough for warming the factory in the coldest weather, then during the greater part of the seven months only a small proportion of the heat would be utilised. This feature is not of much consequence with gas or oil engines, excepting for the reduction in the saving, which may be sufficient to condemn the system. When contemplating steam plant, however, we have to consider whether the amount of heat likely to be utilised will warrant the use of the exhaust steam, and also if a condenser should be added for the sake of economy during warm weather.

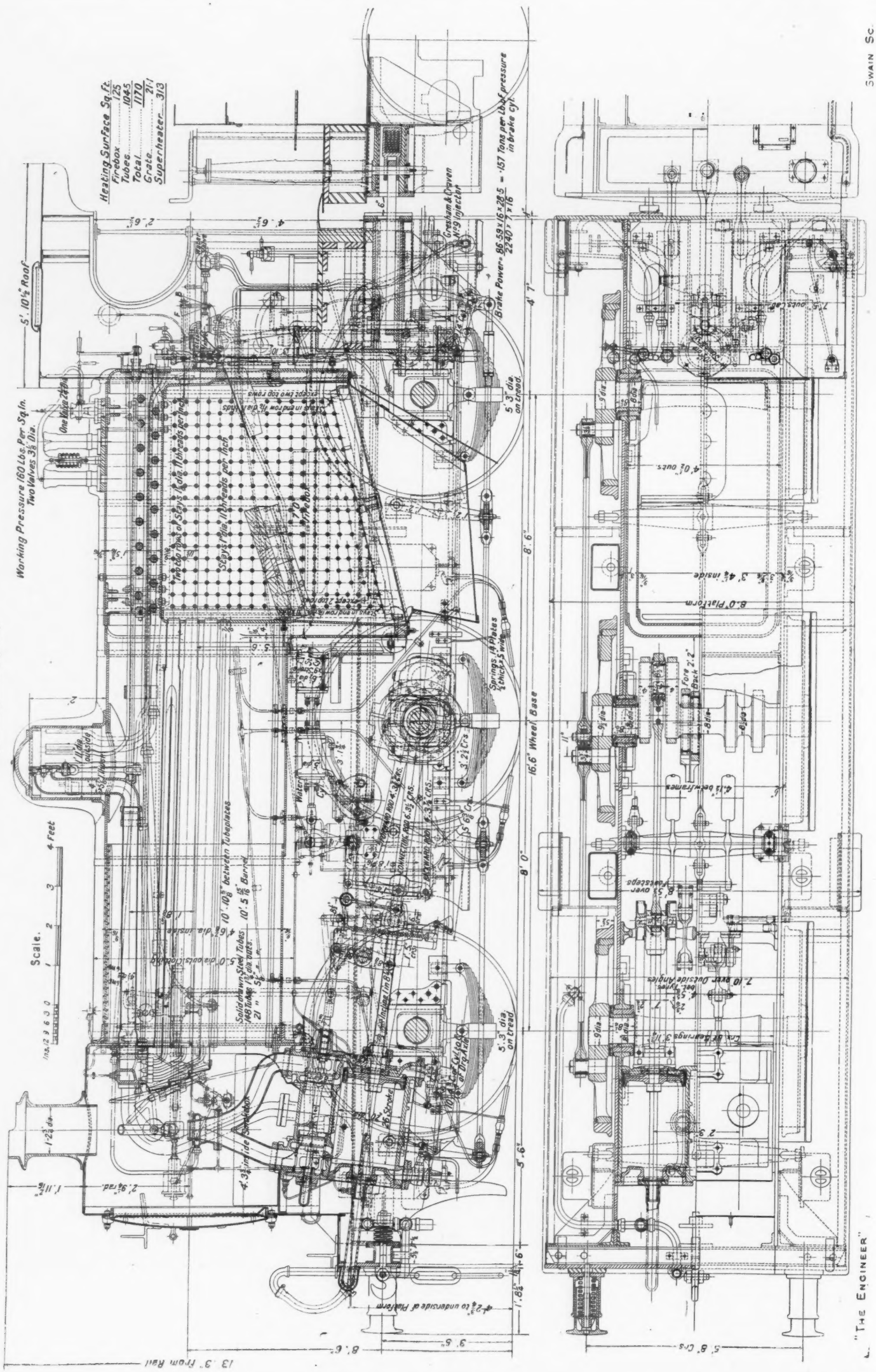
Each case varies in conditions and must be separately worked out; but in general, unless approximately all the available heating power can be used, the standing charges and running costs of the special apparatus will more than counterbalance the advantages obtainable therefrom.

THE survey of the branch railway to the Nigerian tin fields, which will be an extension of 100 miles from Zaria to the foot of the Bauchi plateau, was completed some weeks ago, and by the middle of November half the earthworks had been finished. Rails are now being delivered, and it is expected that the whole line will be ready for traffic in May next.

MIDLAND RAILWAY—SIX-COUPLED SUPERHEATER GOODS ENGINE

MR. HENRY FOWLER, M. INST. C.E., DERBY, ENGINEER

(For description see page 661)


Heating Surface Sq. ft.
Firebox 125
Tubes 1045
Total 1170
Grate 21·1
Superheater 313
Working Pressure 160 Lbs. Per Sq. In.
Two Valves 3½ Dia.
Brake Power = 86·58×16²×26·5 / 22407×16 = ·157 Tons per lb. of pressure in brake cyl.
Graham & Craven Inj. Injector
5' 10½" Roof
5' 3" dia. on tread
Scale.
Feet
Springs: 14 Plates ½ thick 5 wide
Fore 2'2" Back
Cyls. & Motion
Cyls. & Motion
Cyls. & Motion

MIDLAND RAILWAY—SIX-COUPLED SUPERHEATER GOODS ENGINE

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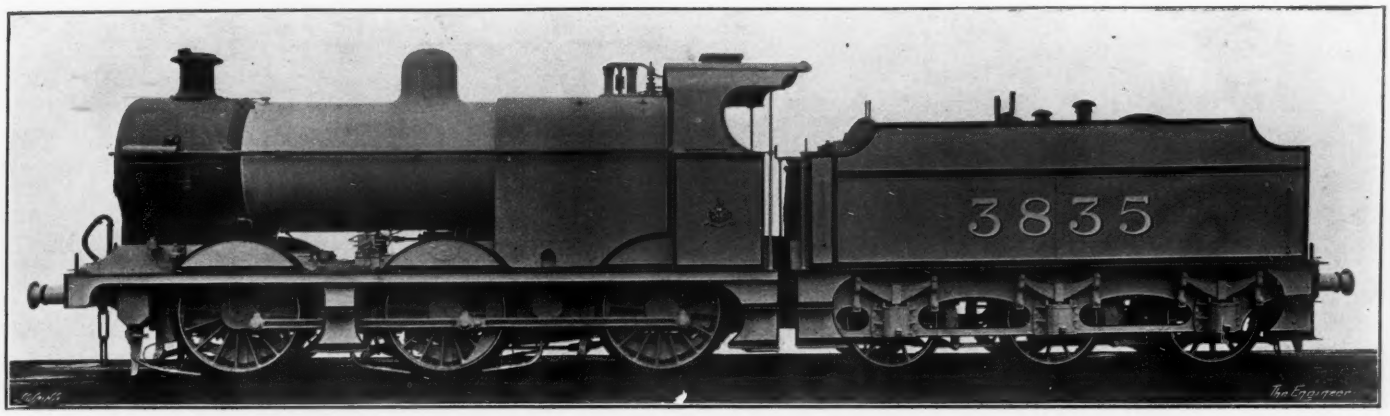
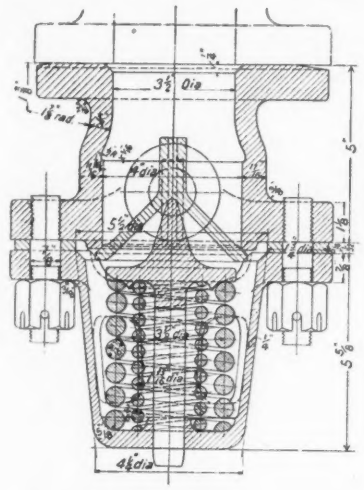


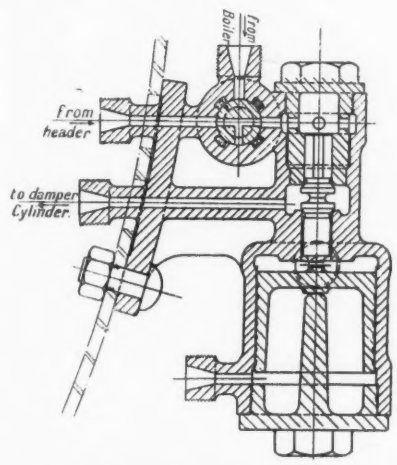
SUPERHEATER GOODS ENGINE, MIDLAND RAILWAY.

A NEW type of 0-6-0 goods engine fitted with Schmidt's superheater has recently been turned out for the Midland Railway by the company's shops at Derby, and on this page and page 660 we give general views and details of this new class of locomotive.

From the general drawing it will be seen that the boiler is of the Belpaire type, and that it is fitted with Schmidt's fire-tube superheater. The superheater dampers are operated by a small steam cylinder arranged on the side of the smoke-box. The valve controlling the supply of steam to this cylinder was the subject of a recent patent granted to Mr. Henry Fowler, the locomotive superintendent to the Midland Railway, and Mr. J. E. Anderson, of Derby, and as such was dealt with by us in our issue of September 8th last. This control valve admits of the superheater being used to full advantage whether the engine is operating a fast non-stop or a slow stopping train. Thus when the control valve is set to "fast train working," the superheater dampers are automatically opened and closed by the opening or closing of the main boiler regulator valve. When, however, the engine has to make frequent short stops this arrangement would, in its aggregate effect, produce a quite noticeable loss of superheat. If the stoppages are short there is little chance of any serious harm being done to the superheater tubes by keeping the apparatus in action, although there is for the moment no steam within the superheater tubes. Hence for a "stopping" train the control valve handle is turned through 45 deg., which results in the dampers being kept open continuously, irrespective of the regulator position. If we suppose the train stopped and the blower applied then with the control valve in the "stopping" position, it is obvious that there is a considerable danger of burning the superheater tubes, since there is now an abnormal draught through the boiler tubes. To obviate this risk the control valve is arranged when in the "stopping" position, to close the dampers if the blower is applied beyond a certain predetermined amount. In one of the accompanying engravings we give a sectional drawing of the control valve.



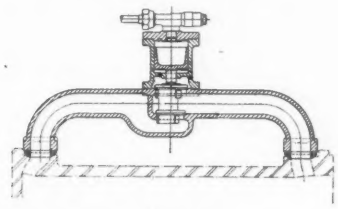
RELIEF VALVE



SUPERHEATER CONTROL VALVE

The engine cylinders are provided with piston valves giving inside admission. The valve motion is of the Midland standard Stephenson pattern with the addition of a rocking shaft. An automatically controlled by-pass pipe connects the forward with the back end of each cylinder. This device is also the patent of Messrs. Fowler and Anderson, and was illustrated in our issue of November 24th. Its object is to relieve the compression and suction in the cylinders, which would otherwise take place when the engine is running with steam shut off. The arrangement of the by-pass is shown in one of the accompanying engravings, from which it will be seen to consist of a pipe provided with a valve half-way along its length. A small cylinder and piston control the valve. Thus it is arranged that the opening of the main regulator valve causes steam pressure to shut the by-pass valve. When the regulator valve is closed, the by-pass valve opens and establishes communication between the two ends of the cylinder.

As will be seen from the general arrangement, steam reversing gear is provided on these engines. The steam and water cylinders are situated on the right-hand side of the engine, inside the frames and immediately over the driving axle.



BY-PASS

The arrangement of the steam and water valves is somewhat novel, as these are both placed in the cab and are connected to their respective cylinders by pipes. This obviates the employment of numerous small rods, levers and cranks. The main cylinders and piston valves are lubricated by an eight-feed mechanical forced lubricator driven from the valve spindle. Steam braking is provided on the engine and tender, and is operated in conjunction with the vacuum brake on the train. Steam sanding is arranged for on the leading and driving wheels. Pressure relief valves, as shown in one of our engravings, are provided on the cylinders. The following are a few of the leading particulars of the engine and tender :—

Cylinders, diameter	20in.
,, stroke	26in.
Wheels, six-coupled, diameter	5ft. 3in.
Boiler barrel, diameter	4ft. 9⅛in.
,, length	10ft. 5⅛in.
,, length between tube plates	10ft. 10⅛in.
Tubes (steel), 1⅜in. outside diameter	148
,, 5⅛in. outside diameter	21
Superheater (Schmidt type)	21 elements
Fire-box shell, length	7ft.
,, width at bottom	4ft. ½in.
Heating surface, fire-box	125 sq. ft.
,, tubes	1045 sq. ft.
,, total	1170 sq. ft.
Superheater surface	313 sq. ft.
Area of fire grate	21.1 sq. ft.
Working pressure	160 lb. per sq. in.
Tractive effort	.0736 tons per lb. steam pressure in cylinder
Tender tank capacity	2950 galls.
Tender, coal capacity	4 tons
Weight of engine in working order	49 t. 2 cwt.
Weight of tender in working order	39 t. 2 qr.

H.M. TORPEDO-BOAT destroyer Attack was launched on December 21st from the yard of Yarrow and Co., Limited, at Scotstoun. The vessel is the second of the five special destroyers which this firm has under construction for the British Admiralty. Her dimensions are 240ft. long by 25ft. 7in. beam, and she is propelled by twin screws driven by turbines of the Brown-Curtis type, which have been made by the builders at their works. Steam is supplied by three Yarrow water-tube boilers burning oil fuel, and they are fitted with a new form of superheater designed by the firm.

OIL-BURNING LOCOMOTIVES ON THE TEHUANTEPEC NATIONAL RAILROAD, MEXICO.*

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THE object of this paper is to give an account of liquid fuel burning in the locomotives of the Tehuantepec National Railway, showing some of its advantages over coal, and giving a general description of facilities for handling and storing this fuel oil, the methods of burning it, and a few results gained which are taken from the monthly performance of locomotives. The author does not intend to deal fully with costs, &c., as it is too large a subject for so short a paper, but will confine himself to a more practical point of view.

The Tehuantepec Railway is a trans-continental line of standard gauge, 189 miles long, running across the Mexican Isthmus of Tehuantepec from the port of Puerto Mexico (Coatzacoalcos) on the Atlantic to the port of Salina Cruz on the Pacific, with gradients varying from level to 2.15 per cent., and abounding in curves up to 100.10 m. radius, and where the speed of trains is limited to 15 miles per hour.

Storage facilities.—All fuel oil for the company is received at the terminal of Puerto Mexico, where the main storage tanks are situated; these comprise three cylindrical steel tanks, each composed of six tiers of steel plates riveted together and a light steel roof with three manholes, and a ventilator in the middle through which gases arising from the oil can escape. Two of these tanks are 95ft. diameter and 37ft. 6in. deep, each with a capacity of 46,996 barrels of 42 United States gallons (35 British gallons) † The third tank is 92ft. diameter and 29ft. 9in. deep, and has a capacity of 35,138 United States barrels.

These tanks are all enclosed in separate earthen embankments, and are connected together by an 8in. pipe line, which enters the tanks 1ft. 6in. from the bottom, this space being required for water, &c., settling out of the oil and which can be drawn off through a 3in. valve at the bottom of the tank. The pipe line runs down to the wharf, where it is fitted with an 8in. check valve, and it is from here that vessels delivering cargoes of oil can pump straight into any tank, the two largest tanks being about 1½ miles from the wharf. At convenient places in the pipe line near to the round-house are stand columns for filling engine tanks, tank cars, &c., and near the round-house is also a supply tank of 28,000 United States gallons capacity, erected upon a structural steel frame, also used for giving oil to engines, &c.

The terminal of Salina Cruz is laid out in the same manner, except that there are only two storage tanks, 95ft. diameter and 37ft. 6in. deep, of 46,996 barrels capacity. The capacity of all these storage tanks has been calculated out in United States barrels of 42 gallons for every 6in. of depth, allowance being made for all internal stays, supports, &c. The fuel oil is shipped from Puerto Mexico to the other fuel stations in specially constructed double-truck steel-frame tank cars of 6600 United States gallons capacity, the gallons per inch of depth of these cars being known, so that the exact amount contained in each car can be credited to the station to which it is shipped.

Fuel oil.—The fuel oil used by this company is purchased from the Texas Company of Port Arthur, Texas, at about 97½ cents gold per barrel of 42 United States gallons delivered at Puerto Mexico, and pumped into the railway company's tanks by the delivering vessel. This fuel oil is generally delivered in tank steamers, sometimes towing barges, which come right up alongside the railway company's wharf; the coupling between the vessel and the company's land pipe line is made with a flexible rubber or steel hose which is supplied by the vessel.

This fuel oil is quite thin and flows readily through pipes of any diameter; it is sometimes nearly black in colour, and sometimes a dark brown with a green fluorescence. The railway company stipulates in its contracts with the Texas Company that the flash-point—closed—shall not be under 110 deg. Fah., as a lower flash-point than this is liable to be dangerous on account of the volatile gases and fumes which arise from the oil at comparatively low temperatures, and the author has seen the oil catch fire from a torch which was some 10ft. or 12ft. away from it. Some oils may be used in the crude state as fuel, while others have to be passed through the refinery; after the lighter oils, &c., have been taken off, the by-product or residuum is used in a satisfactory manner as fuel, and as such has been and is used in Mexico. Fuel oil contains no power of spontaneous combustion, and, unlike coal, does not deteriorate if stored in tanks or reservoirs.

The specific gravity of this oil varies from 0.790 to about 0.942, and its weight per United States gallon from 6.4 to 7.75 lb. The British thermal units vary from 17,000 to 20,000, the average being from 19,500 to 19,800, and between this and the best steam coal there is a very great difference. The analysis of two samples of the oil as used by this company for fuel is as follows :—

Specific gravity at 60 deg. Fah.	0.931	0.881
Baume ,, at ,,	20.5 deg.	29 deg.
Flash-point (closed)	130 deg. Fah.	135 deg. Fah.
,, ,, (open)	160 deg. Fah.	160 deg. Fah.
Fire test	220 deg. Fah.	224 deg. Fah.
Setting point	3 deg. Fah.	20 deg. Fah.
Viscosity at 100 deg. Fah.	200 sec. (Redwood)	78 sec. (Redwood)
Sulphur	0.77 per cent.	0.26 per cent
Calorific value	10,688 calories	11,000 calories
Colour	Dark brown	Dark brown
Water and dirt	1 per cent.	0.25 per cent.

The standard temperature for the measurement of fuel oil is

* The Institution of Mechanical Engineers. See also paper by Louis Greaven (M.) in "Proceedings," 1906, Part II., page 265.

† One United States gallon = 231 cubic inches. One British gallon = 277.27 cubic inches. United States gallon = ⅚ British Imperial gallon. The value of the Mexican dollar is assumed throughout this paper to be 2s.

60 deg. Fah., and expansion is allowed for at the rate of 1 per cent. for every 20 deg. Fah. increase in temperature above 60 deg. Fah., and contraction at the same rate for decrease in temperature below 60 deg. Fah.

Locomotives.—The locomotives in use on this road are of the Baldwin consolidation type, the main dimensions of which are:—

Cylinders	20in. by 26in.
Wheels (drivers)	53in. diameter on tread.
Fire-box	Length inside, 108in.; width inside, 33½in.
Flues	239 of 2in. outside diameter.
Grate area	24.94 square feet.
Heating surface	Fire-box, 147; flues, 1700. Total, 1847 square feet.
Boiler pressure	170 lb. per square inch.

The oil tank is fitted into the coal space of the tender, and its contents calculated for every ½in. of depth; most oil tanks have a capacity of 2000 gallons, and the oil is fed from the tank to the burner or atomiser through suitable connections and flexible brass ball joints.

Fire-box arrangement.—The company's practice, after trying various types of burners and atomisers, is to use what is called a front end burner, Fig. 1, that is, the burner mouth points towards the back of the fire-box or fire-box door plate; the burner is placed in a 9ft. fire-box, 4ft. 2in. from the flue sheet, the flame playing against a brick wall built up to the level of the fire-box door opening. Between this brick wall and the fire-box back plate is a 4in. air space extending the whole width of the fire-box and right up to the top of the brick wall. Brick walls are built up on each side of the fire-box from the height of the brick wall at the back, gradually sloping downwards; the floor of the grate or ash pan is laid all over with fire brick. No brick arch or baffle plate is used.

As mentioned in the preceding paragraph, the burner is placed 4ft. 2in. from the flue sheet, and midway between the sides of the fire-box, so that both in front and behind the burner or atomiser there is a flat bricked-over area of fire grate; and as the burner is placed parallel to the lower grate, there is a 4in. space between the front and back grates, this 4in. space being left open to admit air, extending from one side of the fire-box to the other.

Brickwork.—This should be of the very best material and workmanship, as it is subject to a much greater heat than from a coal fire; if this is not done, the walls will not stand, and engine failures will occur; moreover, the failure of only one brick will perhaps necessitate new brickwork throughout, thus needlessly running up expenses. There is no reason why the brickwork should not stand from four to six months, and perhaps longer, if due care be taken from the start. A good brick should contain about 80 to 85 per cent. of silica and from 20 to 15 per cent. of alumina, and should be as free as possible from alkalies, which cause fluxing. A good brick becomes surface glazed though remaining rough and porous; it should be perfectly dry when built up in a fire-box, otherwise the heat will cause it to crack; if possible, the fire bricks should be fired at a temperature as high as that to which they will be exposed when in use.

Burner or atomiser.—There are many and various kinds of hydrocarbon burners, and after a trial of various types, including the "Baldwin" and "Best" burners, this company is using with considerable success a burner which is made in its own shops, and which is really an inverted "Best" burner—Fig. 2. It is a simple device which allows the oil to fall from an orifice 3in. wide by $\frac{1}{16}$in. deep over the top of a flat steam jet 3in. wide and $\frac{1}{32}$in. deep, the steam picking up the oil and sending it into the fire-box in the form of a spray; the underneath jet of steam delivers the spray of oil at an angle, so that it strikes the brick wall in the middle instead of shooting out from the burner parallel with the bottom of the ashpan. This burner may be called an outside atomiser, and although it is in general use it has its drawbacks; but it has been found to be more efficient than any other they have used.

The most essential points about a burner or atomiser are:—(1) Its atomising capacity. All fuel oil is heavy, and will burn in the form of a vapour or spray only when mixed with air. The object should be to fill the fire-box with a soft and voluminous flame, and not to impinge it in any one place. (2) Its facility for keeping clean and free from clogging. (3) Its adjustability in giving the right direction to the flame or spray, and regulating the proper proportion of oil and the agent, either steam or air, used for atomising. A burner which will vaporise or atomise the oil at the point of expansion of the agent used for that purpose, and which is easily handled, and which will atomise the greatest amount of fuel with the least possible energy, is the highest and most efficient that can be designed. On this railway, steam is used as the atomising agent because, after various experiments, it was found to be superior to air. The steam to a very great extent heats the oil as it flows into the burner before delivery in the form of a vapour spray. The flame from the burner should not be too long, or it will pass into the flues and become extinguished. Gases which are only partly consumed will re-light in the smoke-box.

Lighting up an oil-burning engine.—In each round-house of this company is a stationary boiler, always in steam, used for the wash-out and other pumps, as well as for lighting up dead engines. From this boiler is laid a 2in. steam line to points between each engine road or stall. From there a connection can be made to a locomotive through a three-way cock or T-piece in the steam pipe leading from the steam stand on top of the fire-box to the burner by use of this steam the burner can be started and kept going until the boiler has generated enough steam to keep the burner going itself. A piece of oily waste is lighted and thrown into the fire-box just in front of the burner, from which the spray ignites. Connections can be made to any other engine all ready in steam should the stationary boiler not be available for any reason.

Firing and cleaning flues on road.—With an oil-burning engine there is always a fire of equal intensity and one which never gets dirty, so that good steaming is practically ensured. It is a popular idea that it is a very easy matter to fire an oil-burning engine, but this is not the case, as both skill and care are required, so that the author thinks it best to lay down a few of the most important rules:—(1) See that the oil tank is full, and if heaters are used, that they are in operation, and that the temperature of the oil is as it should be. (2) See that the sand-box on the foot plate is full, and that the scoop is in its place. (3) Before starting the fire, see if the temperature of the fire-box is below igniting point, which is a dull red, and if so open dampers (if used), start the blower, and open the atomiser valve fairly hard; then put a piece of saturated oily waste on the bottom of the grate after setting it alight, close the dampers (if used) and fire-box door, and turn on the oil very light. When the oil has ignited, reduce the blower and atomiser to a light feed, also the oil until the chimney is quite clear of smoke. (4) See that the fire is burning brightly, and that there is no oil on the bottom of the pan, also that the brickwork is in good condition, and that no bricks or any other obstructions are on the bottom of the grate or pan so as to obstruct the flame or jet on its way from the burner to the brick wall. (5) As regards cleaning flues on roads, it is best to sand frequently if the engine is being worked hard, say every 15 or 20 kiloms. (9 or 12½ miles), but if the engine is being worked light, every 50 or 60 kiloms. (31 or 37 miles) will be sufficient. (6) Having attained a fair rate of speed, fill the scoop with about a quart of sand, close dampers (if used) and put reverse-lever near full stroke, then open regulator wide, insert the end of the scoop in the round hole in the fire-box door, and allow the sand to be drawn out of the scoop through the fire-box and flues and out of the chimney; sanding is best done when the engine is working hard up a grade. (7) Black smoke shows incomplete combustion, and should never be allowed to be emitted from the chimney, as it only fills up the flues with carbon, besides being a non-conductor of heat, and it is also a great waste of fuel. If a bluish-coloured smoke or fumes are seen coming from the chimney, it is a sign that the burner is cut down too fine. (8) When putting out the fire, the oil-valve should always be closed first, then the atomiser valve (in their case, steam), then the blower. The oil-valve is always the last to be turned on and the first to be turned off. (9) Never go near an open tank with a lighted lamp or torch, as at any time an explosion may occur, especially if the oil used has a low flash-point.

Round-house or shed work.—An oil-burning engine has a great many advantages over a coal-burner, but this is specially noticed in the round-house or shed when squaring up an engine after a day's run; there are no fires to be raked out, no flues or smoke-box to be cleaned (the smoke-box door of an oil-burning engine need be opened only once every three or four months for cleaning purposes); there is no coal to be sacked, weighed or otherwise handled, and oil-burning engines do not carry fire-rakes, prickers, flue-brushes, shovels or picks, so that all these things, besides other minor details, represent a great saving in engine equipment.

Among other advantages are the rapidity with which steam can be raised, and the facility with which the boiler can be forced when greater calls are made; the author has in a special case of necessity raised steam in a dead engine to a pressure of 130 lb. per square inch in 50 minutes from cold water, without any serious effects on the boiler, whereas in a coal burner from 2 to 3½ hours is needed to raise steam if no jet from a live engine is used.

Another very great advantage is in switching or shunting, or standing pilot, when engines frequently have to stand in steam for hours at a time. The burner can then be cut down or extinguished, thus effecting a great saving in fuel, as an engine will already retain a sufficient amount of steam to start the burner or atomiser again, and any danger of the fire-box or crown sheet being injured through the water getting too low is entirely obviated. The heat lost while standing is the same whether coal fired or oil fired.

Effects of oil burning on fire-box, flues, &c.—Oil burning is no more injurious to a fire-box or flues, &c., if ordinary care be used, than coal burning: in fact, from the author's experience, it is not so hard on a fire-box as coal burning, for it is quite noticeable in the fire-boxes of coal burning engines that stay heads, plate edges, flue ends, and crown bolt heads show signs of wear, corrosion, or burning; but in their oldest oil burning engine not any of these signs are noticeable, everything being clean and in good condition.

This company uses steel boxes with wrought iron tubes and copper ferrules. A set of tubes will last and remain perfectly tight from two and a-half to three and a-half years, when they may have to be taken out to be re-ended; some of the engines are working to-day with tubes over four years old, many of which are as tight as the day they were put in. Some of the wrought iron tubes are being replaced by mild steel, because, after the holes in the tube sheet get worn, tubes of steel stand the expanding better; but at present those that are in service have not been in use long enough for one to form an opinion of them as compared with wrought iron.

FIG. 1.—*Front-end Oil-fuel Burner arranged in Locomotive Fire-box.*

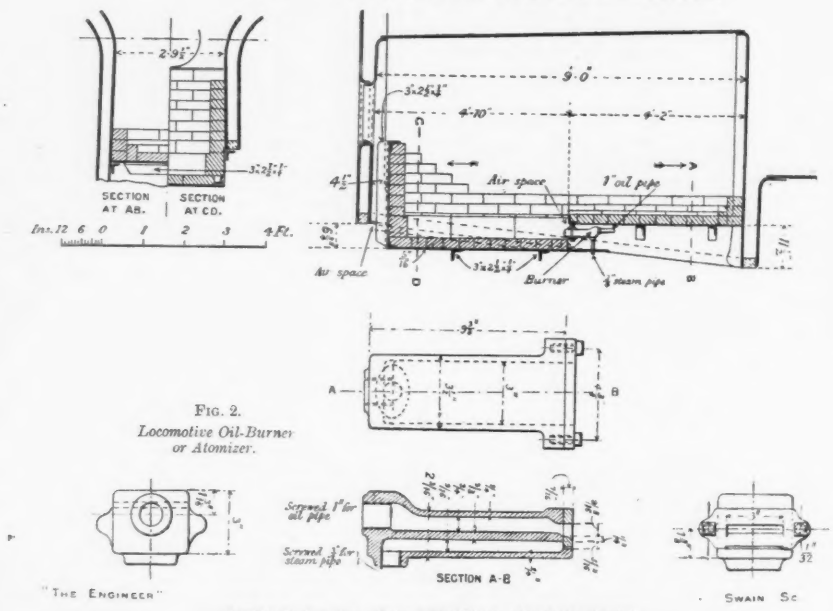


FIG. 2. *Locomotive Oil-Burner or Atomizer.*

DETAILS OF OIL FUEL BURNING ARRANGEMENTS

Some people are of the opinion that more than 2 per cent. of sulphur in fuel oil is injurious to the fire-box, but as the amount of sulphur in the Texas oil the company has been using is below 0.75 per cent. no ill effects have been noticed; but as there are coals which show as high as 3.5 per cent., the author does not see why sulphur should be more injurious in oil than in coal.

Engine performance.—Although the engine tonnage has practically doubled since 1908, the author gives the following statistics for every month from January, 1907, to August, 1911:—(1) Cost of fuel oil per barrel of 42 gallons (Mexican currency); (2) cost per kilom. for fuel (Mexican currency); and (3) kiloms. run per barrel of oil; but it must be understood that since about the middle of 1909 all engines are loaded down to their capacity, single trains averaging 750 to 800 tons behind the drawbar. As the road bed is by no means level, helper engines are used over certain sections where the grades are long and heavy, so that this will explain the decrease in kiloms. run per barrel of oil between 1908, 1909, 1910, 1911, as the tonnage per engine has been increased to the maximum.

Oil Fuel. Monthly Averages.

During	Cost of oil per barrel.		Cost for fuel.		Distance run per barrel.	
	Dols. (Mexican)	Shillings	Cents per kilom.	Pence per mile	Kiloms.	Miles.
1907	2.585	5.17	28.476	10.99	9.546	5.928
1908	2.957	5.91	27.151	10.48	11.04	6.855
1909	2.502	5.01	25.19	9.73	9.999	6.209
1910	2.356	4.71	25.02	9.66	9.41	5.843
1911 (8 months)	1.990	3.98	22.23	8.58	8.89	5.520

The cost of fuel oil per barrel of 42 United States gallons (231 cubic inches) as charged out every month is made up of the following items, and also depends upon whether there is any shortage or overage when the inventory is taken at midnight on the last day of each month; this accounts for the variation in prices:—(1) Price of oil per barrel f.o.b. in ships' tanks at delivering port (Puerto Mexico); (2) commission to purchasing agents in United States; (3) consular invoices; (4) inspection fees for inspecting cargo in ships' tanks at shipping port; (5) stamps. Items 2, 3, and 4 only refer to oil purchased out of Mexico. Based on tests which have been made, the company reckons three and a-half barrels, or 147 United States gallons, of oil as being equal to one ton of coal or 1000 kilos., or 2204 lb. or three and a-half barrels of oil equal one unit of fuel.

The author is unable at this time to give any reliable data of fuel consumption on a tonnage basis, as no records are kept of company freight hauled over the road, which is considerable, but the average loaded passenger and freight cars hauled 1 kilom. per unit of fuel from January 1st to December 31st, 1910, was 330 89, and from January 1st to June 30th, 1911, was 333 60. The average loading weight of freight cars is approximately 30 tons. In August this year (1911) the company received the first cargo of a native or Mexican fuel oil under a contract with the "Campañia Mexicana de Petroleo," El Aguila, S.A., at a price of 1.75 dol. (Mexican) (3s. 6d.) per barrel of 42 United States gallons delivered into railway company's tanks at Puerto Mexico. This oil, which is used in its crude state as fuel, is jet black in colour, thick, and has a heavy asphalt base, and, although the company has not used it sufficiently long to be able to compare it with the Texas oil, it may be of interest to state a few of the difficulties met with when first they began to use it.

As this oil is thicker than Texas oil, heaters have to be used in the engine tanks, but it has been found that if this oil is heated up to about 150 deg. Fah.—which can be done with Texas oil—great difficulty is experienced in getting the burner spray to light, and that the oil settled very thickly at the bottom of the tank; it would not run through the pipes to the burner, and could only be burnt effectively by mixing a fresh supply of oil with it. In order to burn this Mexican native oil successfully, it requires to be only just warmed. When using this, a large piece of carbon or coke-like substance is formed in the fire-box, and grows up from the bottom of the pan or grate directly under the burner mouth. This may vary from 6in. by 4in. by 4in. to 12in. by 10in. by 8in. in size, growing up in such a manner as almost to smother the burner mouth. The analysis of this substance is as follows:—

	Per cent.
Ash	1.25
Sulphur	7.89
Carbon	90.86
Asphalt	nil.

It shows to a certain extent that there is incomplete combustion, which can be remedied by admitting more air; but this cannot very well be done without affecting the steaming qualities of the engines. However, by raising the burner slightly these lumps of carbon have decreased in size, and it is hoped eventually to adjust things in such a manner as to prevent their forming at all.

The analysis of two cargoes of this Mexican crude fuel oil is as follows:—

	No. 1.	No. 2.
Specific gravity at 60 deg. Fah.	0.944	0.942
Baume at ,,	18.4 deg.	18.8 deg.
Flash point (closed)	78 deg. Fah.	102 deg. Fah.
,, (open)	104 deg. Fah.	120 deg. Fah.
Fire test	165 deg. Fah.	180 deg. Fah.
Viscosity at 100 deg. Fah.	1080 seconds (Redwood)	920 seconds (Redwood)
Sulphur	3.44 per cent.	3.35 per cent.
Calorific value	10,971 calories	10,610 salories
Colour	Black	Black
Water	nil.	0.5 per cent.
Asphalt	—	37 per cent.
Carbon (coke)	—	12 per cent.

It may be explained that the 37 per cent. asphalt is obtained by distilling off the distillates from the crude until only 37 per cent. residue is left, which consists of asphalt. The 12 per cent. coke is obtained by distilling this 37 per cent. down to 12 per cent. residue (on the crude), so that if they get 37 per cent. asphalt, they do not get the 12 per cent. coke, and if they get the 12 per cent. coke, they do not get the 37 per cent. asphalt.

The author regrets that at this time he is unable to go deeper into this subject, but he hopes that what little information he has been able to give with regard to oil fuel burning in the Tehuantepec locomotives will be of interest to others working in the same direction.

THE tensile strength of aluminium is half that of copper per unit of area, so that per unit of weight aluminium is 50 per cent. stronger. As compared with copper an aluminium conductor must be larger in diameter by about 28 per cent. With expensive insulation aluminium has so far some disadvantage, but, notwithstanding this, marked economies may be effected by the employment of aluminium for low-tension insulated cables. Once thought so difficult to solder, aluminium can now be jointed after a little practice by butt welding with a blow lamp, and cables may be jointed by butting them and pouring melted aluminium from a common iron ladle, such joints being fully equal to the original wire in conductivity. For jointing overhead cables, however, the two ends are threaded parallel with each other through a tube of thin aluminium of S section, with open centre and twisted together.

RAILWAY MATTERS.

OF the 50,000 passenger cars in use on the steam railways of the United States, 11,017 are electrically lighted. The 58 railways, which include the Pullman Company, that operate these cars have 33,634 other cars not electrically lighted. The systems used are as follows:—Simple storage batteries, 1372 cars; head-end, 192 turbine-generator cars and 3185 cars lighted; axle-generator cars, 5900. The Pullman Company operates 2400 electrically lighted cars out of its 4264 cars in service, using the axle-generator system exclusively.

IT is calculated that 69 per cent. of all railway earnings in the United States is derived from freight, while 23 per cent. of all railway earnings is derived from passengers, and 8 per cent. from miscellaneous sources. About two-thirds of the gross earnings of railways are consumed in their operation, leaving one-third for fixed charges, dividends on stock, and for betterments and improvements. The railways of the United States employ 1,500,000 persons, at a cost of about £200,000,000, equal to 35.7 per cent. of the gross earnings.

AT the beginning of this year, states the *Railway News*, there were about 3000 passenger cars in service in the United States built of all-steel construction. The total number of passenger coaches is about 54,600, so that the number of steel cars is about 5.3 per cent. of the total. Of the cars constructed during the present year 62 per cent. will be all-steel construction, so that at the end of this year fully 9.3 per cent. of all passenger cars will be of steel, while 3.5 per cent. have steel underframes. The percentage of wooden cars in service has dropped in the last three years from 98.2 to 87.2 per cent.

IT is reported that the London and North-Western Railway Company will early next year commence improvements at New Street Station, Birmingham, and an extension of the Queen's Hotel adjoining, involving an outlay of £100,000. The booking hall is to be enlarged, and a handsome entrance hall provided. Two broad staircases will lead to the bridge, and the present inconvenient gangways will be dispensed with. High pressure gas and electricity will be used for lighting. The hotel is to be extended to the corner of Navigation-street, and additions made which will have the effect of nearly doubling the accommodation.

VERY little has been said about the traffic through the Simplon tunnel since it was opened, but the report of the Italian State Railways gives the quantity of goods which enters and leaves the country at each border station, and from this it appears that in the year ending with June, 1910, 56,335 tons of freight entered Italy, and 74,764 left it by that route, an average per day of 154 and 205 tons. The average number of goods wagons daily was 18 in and 21 out. The imports by the Mount Cenis route were nearly six times, and by the Gotthard thirteen times as great; the exports by the Mount Cenis route twice, and by the Gotthard six times as great.

A RAIL grinder was recently described in the *Electric Railway Journal* by which it is said that corrugations can be ground out at a cost of from ¾d. to 1d. per foot. The apparatus consists of a four-wheeled truck, on which is mounted a motor which drives through friction gear and belts a series of emery wheels, supported by a carriage 5ft. 10in. long, resting on four adjustable shoes for sliding along the rails. The machine can propel itself with the grinding wheels raised clear of the rails. The trolley stand is 7½ft. high, and the motor for moving the car is mounted on top of the frame, and drives through a belt and gearing.

A FUEL test with a passenger train of ten cars weighing 560 tons was recently made on the Lehigh Valley from Buffalo, New York, to Jersey City, N.J., 446.6 miles, by running one locomotive through without change. The time on the road was twelve hours, the amount of bituminous coal burned 15 tons. The average steam pressure was 195 lb. The interesting feature of the performance was not so much the endurance of the machinery without adjustment or repair, as the small amount of coal burned and the manner in which the fire was handled. The amount of coal usually burned on the same run when several engines are used is 25 tons. The report of the tests states that the fire was not cleaned or raked, and the grates were shaked slightly and only six times.

WORK is being actively pushed on the construction of the 47-mile line between Jinja, on Lake Victoria Nyanza, Africa, and Kakindu, in the direction of Lake Kioga. This is the first railway to be constructed in the Uganda Protectorate, as the Uganda Railway from Mombasa on the Indian Ocean to Port Florence on Lake Victoria Nyanza lies entirely in the East Africa Protectorate. The Jinja-Kakindu line is not destined to become the main line of the Uganda railway system, its primary object being to link up the two lakes. When completed, however, its influence on the traffic of north-eastern Africa will be considerable, as it will form the last link but two of a route 3850 miles long between Cairo and Mombasa, made up of a series of railways and navigable waterways. The two missing links in this route will be from Gondokora to Dufile, and from Wadelai to Foweira, a total of 170 miles.

AT a time when so much praise is being bestowed upon the working of the single-phase system on the London, Brighton, and South Coast Railway, the following, which was written by a well-known electrical engineer about three years ago, is of considerable interest:—"If it is clearly understood in railway circles that electrical engineers have developed far better means of railway electrification, the writer is, personally, well satisfied that the London, Brighton, and South Coast Railway should have adopted the single-phase system. They will thus, although at considerable expense, provide the railway and engineering world with a practical demonstration of its inferiority for such a service. If, on the other hand, railway directors should conclude that this single-phase monstrosity is the best thing that engineers have to put forward for railway electrification, the impending exposure will, when it arrives, discredit electrical engineering, and will be all the more disastrous the longer it is deferred." We are confident that the author of these lines has now seen reason to alter his opinion.

IN discussing efficiency in locomotive coal consumption an American engineer of large experience said:—"There are more grates burned out, more coal wasted on account of green coal passing to the ashpan, and more ashpans burned and warped from excessive shaking of grates than from any other cause. The practice should be restricted, and the rule adopted to shake grates as little as possible consistent with the maintenance of regular boiler pressure and steam making capacity. It is understood that as the ashes accumulate on the grate the depth of the fire increases and there is an advantage in having this layer of ash on the grate, as it prevents the leakage of good coal, warms to some extent the air passing through it, and perhaps helps to distribute it more evenly. It also prevents the excessive passage of air into the fire-box where there are holes in the fire and the coal bed is too thin. The excess air cools the furnace and rapidly reduces the rate of steam production. The strong blast of the exhaust is for the time sufficient to supply the proper amount of air for combustion, and it causes sufficient stirring of the fire to allow the lighter portions of the ash to pass out through the tubes and up the stack. In this way a fire may be maintained for a long run without shaking the grates or causing such a deep accumulation of coarser ash as would prevent the admission of sufficient air to the fire."

NOTES AND MEMORANDA.

IT is reported in the *Electrical Review* that at the Highfield Nurseries, Billericay, electrical apparatus, patented by Mr. T. Clark, of Bristol, has been erected in connection with a new glass-house 200ft. in length, for the "intensified" cultivation of tomatoes, cucumbers, and strawberries. An influence machine is used to supply static electricity to 1000ft. of wire suspended overhead in the glass-house.

ONE of the things that worries a man who is thinking of grinding his work is, states the *American Machinist*, the wear of the wheel. He knows that all things wear and he naturally expects this to show on the diameter of a long shaft. But he quite forgets the wear of a lathe tool in turning up the same shaft. And there will be several times the wear to the tool that will be to the grinding wheel in doing this work. This, it adds, can be proved on any long grinding job in the shop.

THE author of a paper read before the American Institute of Electrical Engineers maintains that where the load of the motor at any speed is approximately constant, as when driving fans, pumps, printing presses, long line shafts, &c., resistance control is practical, although not always economical. Where the required torque decreases with the speed, as in the case of fans or centrifugal pumps, the use of resistance is economical, since it reduces the current taken from the line, but where the torque is constant, as for plunger pumps or positive pressure blowers, the only economy obtained by such control is in reduction of wear and tear on the apparatus, although convenience may warrant its installation independently of economical considerations.

AT a recent meeting of the Deutsche Chemische Gesellschaft, referred to in the *Electrician*, Messrs. F. Fischer and E. Tiede described a resistance furnace, consisting of a tube of tungsten, made according to H. von Wartenberg's process. The tube has a length of 8 cm., a diameter of 1.6 cm., and a wall thickness of 3 mm, and it can take a power of 3000 watts in a vacuum. It fits at its two ends into the electrodes, two rods of copper, which are fitted with cooling pipes. The rods and the tube form the horizontal diameter of a glass globe, which is kept wetted with water. A greased rubber tube leads over to the air pump. The cooling of the electrodes is so effective that a good vacuum can be maintained. A small magnesia crucible can be placed in a hole drilled in the tungsten tube. In this furnace 1.5 grammes of tin were distilled in five minutes.

ACCORDING to the *Electrical Review*, as the result of experiments made at Trollhättan in the smelting of iron ore by electricity, it is stated that by means of circular instead of square carbon-electrodes, which can be screwed into each other, the electrode consumption per ton of pig iron has decreased from 10.28 kilos.—including the valueless end pieces—to 5.5 kilos. By placing the charge more in the middle of the furnace the experimenters have succeeded in raising the percentage of carbonic acid up to 30 per cent. The consumption of electrical energy has decreased to 1736 kilowatt hours per ton of pig iron, as compared with 2391 kilowatt hours in previous trials. The consumption of charcoal per ton of pig iron, which during previous trials amounted to 418 kilos.—the best result being 370 kilos.—has now decreased to 336 kilos., the amount originally estimated. Calculations based on these results show a saving of over 6 kr. (6s. 8d.) in the production of a ton of pig iron. It is hoped that 368 tons of pig iron can be produced per horse-power per annum.

WE learn from a contemporary that Count Georg von Arco, in the course of a lecture delivered in Berlin, discussed the subject of wireless telegraphy. He is reported to have stated that the question had for a long time remained undecided whether the distant effects were caused through the air or the earth, or through both media simultaneously. During the course of years experts became more of the opinion that the earth was largely concerned with the transmission. In order to obtain information on the matter, systematic experiments had been made during the past two years by Dr. Kiebitz, on behalf of the German postal authorities. It was found in this connection that electrical energy was transmitted for considerable distances through the earth, and that in the case of great distances sufficient energy could even be taken from the earth alone for the purpose of reception. Stimulated by these results, the Gesellschaft für Drahtlose Telegraphie had made numerous experiments in the past year, and had applied for various improvements in patents. The effects of the earth antennæ were sharply directed, and the antennæ in many respects showed advantages over air antennæ. In particular it was possible considerably to increase the security against interruptions by atmospheric discharges and by stations causing disturbances.

THE penetration of inorganic preservative into treated wood can be determined by a visual method described by Mr. E. Bateman, Chemist in Forest Products, United States Forest Service, in Circular 190 of the service. A representative disc of the treated wood is cut and, in the case of zinc chloride preservative, the freshly cut surface is dipped for not more than ten seconds in a 1 per cent. solution of potassium ferrocyanide. The excess is removed by blotting paper and the block dipped into a 1 per cent. solution of uranium acetate and allowed to dry. The un-impregnated portions of the disc will have a dark red colour, while the treated portions will be slightly whiter than the natural wood. Careful chemical tests of the preservative content of different portions of sample discs has shown that as small amounts of zinc chloride as 0.2 lb. per cubic foot can be thus detected. This test is not successful with red oak on account of the natural colour of the wood. In testing for penetration of a copper salt preservative it is necessary to dip only once—into a solution of potassium ferrocyanide; the penetrated zone is shown by a dark red stain. The same test for penetration of an iron salt would show a deep blue stain. Mercuric chloride can be tested for with a solution of hydrogen sulphide, which replaces the mercuric chloride with a black sulphide, showing as stain. The solution is conveniently prepared by acidifying a solution of sodium sulphide.

IT appears, from a paper read before the Cleveland Institution of Engineers by Mr. Antony Ablett, that in Europe there are thirty electrically driven reversing rolling mill equipments at work, and fifteen more are in course of construction, making forty-five in all. Out of this number twenty-three are in Germany, eight in Austria, seven in France, six in England, and one in Italy. Twelve of these plants are driving cogging mills, five are arranged for reversing motors to drive both cogging and finishing mill, ten are driving finishing mills alone, three are driving copper plate mills, and in one case slabs weighing up to five tons are being rolled, three are driving armour plate mills, three are driving plate mills, and two are driving boiler tube mills. Seven of these reversing mill plants are installed for driving three-high mills on the Ilgner system. It is interesting to note the number of electrical reversing mill equipments which have been put down for driving finishing mills, as the opinion has been held in some quarters that electrical driving possesses no advantage for finishing mills, as the passes are so long that the fly-wheel would lose all its stored energy. The fact that thirteen of these electrical reversing mill plants are driving finishing mills tends to show that this opinion is unfounded. Three of the above-named mills are rolling tin bars, where, on account of the long length of the finished bar there is every prospect that the stored energy of the fly-wheel might become exhausted if there was any likelihood at all of this happening. The power for the majority of the above-mentioned reversing mill plants is supplied by gas-engine driven electric generators.

MISCELLANEA.

A PARLIAMENTARY return, just issued, gives the total number of smoke-consuming furnaces in the various police districts of the Metropolis at 7875, including 265 furnaces fitted in steamboats on the Thames. The number of convictions sought for and obtained before the magistrates in respect of smoke nuisances since the operation of the Act, in 1854, amounts to 672. There are 54 different constructions of apparatus at the various manufactories, works, &c., in the Metropolis, all of which work well and prevent nuisance from smoke. The number of furnaces in the City of London is 397, the convictions two, and five persons are employed as examiners of furnaces. The return also gives the regulations of the Police Commissioners for enforcing the provisions of the Smoke Act.

WE hear that the new surveying trawler Daisy, built for the Royal Navy, will shortly be ready for delivery, and instructions have been issued for a skeleton crew to be selected at the Chatham Depôt to man her on her being taken over from the contractors. The Daisy is afterwards to be taken to Chatham Dockyard, where she will be prepared for commencing surveying duties in April next. The Esther, a sister vessel to the Daisy, is being built, and also a larger surveying vessel, to be named Endeavour, which will have a displacement of 1280 tons, and will be fitted with engines of 1110 horse-power. The Daisy, Esther, and Endeavour will be the first surveying vessels specially built for the naval service for upwards of twenty years, most of the ships fitted out in late years for surveying work being converted war-sloops.

ASKED whether he had yet been able to establish any £3 telephone installations for the benefit of farmers and other rural residents, the Postmaster-General recently stated that the low rate of £3 a year for rural party lines was based on the assumption that an average of three subscribers per mile of route would be obtained. A large number of localities had now been actively canvassed, and it was clear that more than two subscribers per mile could not be hoped for except in a very few special cases. To meet this condition an increase in the charge would be necessary to cover only the direct cost of the lines and operating, without allowing anything for the general expenses of the exchanges with which the lines were connected, and he hoped shortly to be able to offer a modified scheme of rates to meet the same conditions in different localities.

THERE was exhibited on the Danube at Vienna during the early part of November a boat which is controlled by wireless electricity from the bank without any person being on board. The boat carries a storage battery, which furnishes its motive power, the "system" or invention consisting in the adaptation of wireless electric waves of different lengths to the control of the motive power, steering gear, and other mechanism. This system, it is also claimed, will prevent disturbance by electric waves elsewhere generated within the same sphere of influence. At a recent exhibition the boat was manifestly operated without other control than that exercised by the manipulator of the wireless mechanism on the bank. The mechanism is, however, far from perfect, the speed is not great, the responses to the operator's will are hesitating and inexact, and the range is limited to a few score yards. The exhibition, in fact, was notable only as the beginning of the development of a mechanism of possible importance.

BY the extension of the breakwater Brixham will soon possess the finest harbour along the western coast. The town is dependent upon the fishing industry, its fleet being the second largest round the coast, and the extension has become possible largely through the assistance of the Government. For thirty years the Brixham Fishing Smack Insurance Society has paid an average of over £1000 a year in the satisfaction of claims for damage to boats in harbour, and there has for some time been an agitation in favour of lengthening the breakwater from 2000ft. to 3000ft., and adding to it a patent slip or gridiron. The District Council appealed to the Government Development Commissioners for a free grant of £25,000 towards the cost, which was estimated at £40,000. A visit of inspection was paid by representatives of the Commissioners, the Board of Trade, and the Fishery Board, as the result of which it is announced that the Commissioners have decided to make a free grant of £10,000, and to lend the balance of £30,000. The breakwater was recently extended from 1000ft. to 2000ft., and towards the cost of £23,000 the Government agreed to make a grant of £17,000. During south-easterly gales the roadstead is now largely used by steamers passing along the English Channel.

THE following is taken from a report made by Mr. Thomas H. Norton, United States Consul, on the chemical industries of Norway:—"It is in the recent establishment of electro-chemical industries upon a grand scale that Norway has disclosed her latent power as a coming factor in the field of applied chemistry. The vast, hitherto almost neglected, water power is now being harnessed, one factory after another is coming into existence, and soon the kingdom will present a remarkable exhibit of varied chemical industries, contributing largely to the world's markets and enriching rapidly the land. This change began in 1899, when the first calcium carbide factory was built. The number of works has steadily increased, until now there are seven in operation. In 1905 the first air-nitrate works began operation; now a second, on a much larger scale, is about to open, and others are planned. In addition, there is a factory for cyanamide, one for sodium, one for aluminium, one for nickel, one for ferro-silicon, and one for electro-steel. There are also several smaller experimental plants. The products of these factories exported in 1910 had the following values:—Calcium carbide, £325,400; calcium cyanamide, £37,000; calcium nitrate, £101,400; sodium nitrate, £11,600; sodium nitrite, £61,800; aluminium, £87,400; sodium, £12,600; ferro-silicon, £38,400; total, £675,600. The exported products in the above categories were valued at £543,400 in 1909. The annual increase at present in the value of electro-chemical products, as far as it can be measured by export statistics, is thus £132,000.

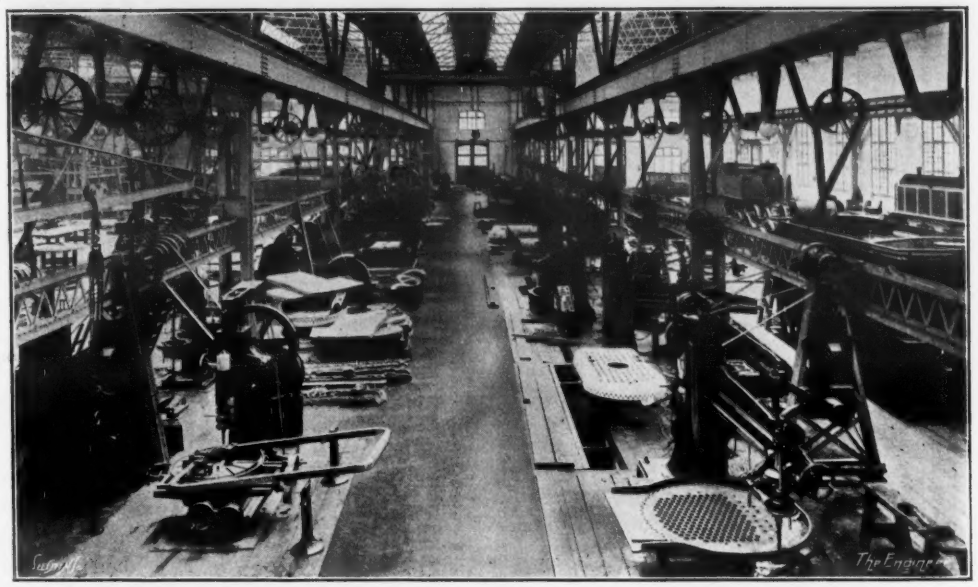
AT a recent meeting of the Special Purposes Section of the North of England Gas Managers' Association, Mr. J. H. Singleton gave an address on "The Uses and Advantages of Gas for Industrial Purposes." Regarding to the question of the cost of using coal gas as a fuel, Mr. Singleton said he did not wish to conceal the fact that it had many competitors other than solid fuel. For example, producer gas was a serious one on account of its low cost. It did not pay, however, to erect plant for making producer gas specially for industrial purposes; and, moreover, it must be remembered that this gas had only about one-fifth the heating power of coal gas. Oil, too, was being largely used in some districts; but though it was a cheap and efficient fuel, it had its drawbacks, such as congealing in the supply tank and carbonising at the jet. Further, it was rather difficult to start, especially the crude oil. Then there was electricity, but Mr. Singleton said he thought his audience need not trouble themselves about this—at any rate, on a large scale. The cost of producing current was too high. Finally, there was petrol gas; but its heating value was not more than that of a poor producer gas. In conclusion, Mr. Singleton said that, so far as he could see therefore, the only competitive fuels which had to be considered seriously were the solid ones; and these had only their cost in their favour. One pound of coal had twenty times the number of heat units contained in a cubic foot of coal gas. But how many, he asked, could be utilised? Its great disadvantage was that the heat of coal could not be directed to the place where it was wanted while that of coal gas could.

NORTH-EASTERN RAILWAY COMPANY'S NEW BOILER SHOP AT DARLINGTON

(For description see page 655)

BOILER SHOP, LOOKING NORTH

BOILER REPAIR SHOP, LOOKING SOUTH



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MEETINGS NEXT WEEK.

(*See "Forthcoming Engagements" page* 673.)

THE ENGINEER.

DECEMBER 29, 1911.

The Progress of Aviation.

THE exhibition of aeroplanes in Paris shows that there is a considerably increasing interest in the science of aviation. It appeals to the public with special force, because the new science is not only attractive in itself, but is regarded as a powerful factor in national defence, and having already given certain positive results it must be encouraged in every possible way. It is this confidence in the future which can alone explain why so many men with ideas are disposed to back them up with capital, upon which there is little hope of getting an early return. Certainly it would need a very sanguine temperament to expect that profitable business could be done in many of the machines exhibited. On the other hand, those firms which build aeroplanes that have proved their value in the various competitions are assured of obtaining orders from home and foreign Governments, but as the conditions imposed become more exacting it is obviously less easy to meet the requirements of buyers. Until recently makers have been encouraged by the prospect of winning large sums of money in the various speed contests. In the designing of machines everything has been rendered subservient to speed. Engines are now fitted developing 140 horse-power and even 200 horse-power. This increase of speed conduces to safety in flight, but it augments the dangers of alighting. When flying at high speeds the machine passes through "air holes," air whirls, and even violent air currents without the equilibrium being so far disturbed that it cannot be easily adjusted by the pilot. As the higher speed necessitates a reduced sustaining surface the machine must come to earth at a relatively high speed, and the risk of accident is thereby increased. Nearly all the numerous accidents that have taken place during the year have been due to this cause. When the pilot is gliding he relies upon the contact for starting the engine in the event of his being obliged to rise again, or of his falling into an "air hole," or of being struck by a strong current. The propeller may have stopped, and the engine fails to start on the contact. The machine having lost speed is unable to negotiate these obstacles and plunges to earth. If flight in fair weather were less easy the danger would probably not be so great, since the piloting of an aeroplane would necessitate extreme caution. When a machine is flying in a calm there is such a complete sense of security that the pilot may allow his attention to be distracted, and without a moment's notice a strong current may turn the aeroplane over to an angle from which it cannot be righted. As the pilot cannot see the "air holes" or whirls he must instantly respond to every movement of the machine. This is to a large extent instinctive, but the most expert pilot is helpless if he is unable to accelerate his speed when gliding. As an alternative, there have always been suggestions of planes sliding one within the other so that they can be drawn out to offer a large sustaining surface at low speeds. Several such machines have been built, but they have never given satisfactory results. The trouble arises from the fact that the planes cannot be drawn out when wanted, probably through their being held together by the sustaining pressure.

From what we have said it will be inferred that, as a practical machine, the aeroplane has made no progress during the past year. At the recent trials the French War Department endeavoured to direct research into more promising channels by basing the results upon $\frac{\text{Speed} \times \text{Useful Load}}{\text{Fuel Consumption}}$, but the test was far from proving satisfactory. The Nieuport monoplane obtained the highest number of points, and having shown itself the most efficient, there is a decided tendency amongst makers to copy this type, as they copied the Bleriot, so long as this machine showed a superiority in speed contests. The Nieuport has certainly shown what can be done in the way of reducing resistance and utilising power to better advantage, but this is an improvement that does not point the way to perfection in aeroplane design. It is an improvement to a type that does not seem capable of perfection. The formula of the French War Department, in which useful load is an important factor, must necessarily help to advance the design of aeroplanes, since load favours stability; but, on the whole, it does not appear as if any better regulation can be imposed than that suggested some time ago whereby aeroplanes should be required to fly at ten and a hundred kilometres an hour. Such a regulation is, of course, quite impossible, for the reason that there is not a machine in existence capable of performing this feat. A wide range of speed is the only proof that a machine is really practical. The shortcomings of existing types of aeroplanes were strongly emphasised at the Turin Congress, when it was stated that accidents were due to engine troubles, absence of reserve of motive power for negotiating air holes and whirls, imperfection of the propeller, absence of sufficient margin of security in the construction of aeroplanes, defective arrangements of engines and tanks, and want of suitable means of landing safely. So far as concerns most of these points it is certain that the Paris Exhibition shows notable improvement. It is evident that the great majority of makers have got over their preconceived ideas that an aeroplane should be built as lightly as possible. Until recently they carried this craze for lightness to an extreme, and every ounce that could be cut out was sacrificed without any regard to security. So many lives have been lost through this absurd cutting down of weight that makers are adopting a more rational attitude, in which they have been encouraged by the heavy loads carried by aeroplanes. Wood has been almost exclusively used because it was light and easily repaired, but the strength of this construction depends entirely upon bracing with wire which may slip at the connections or break through rust and neglect. At the Exhibition there is quite a number of machines constructed of tubes and some of them have metallic planes. Flexibility of planes was, of course, necessary when they had to be warped, but in view of the action over the Wright patents it is probable that an attempt will be made to abandon the warping and to employ more generally small controlling planes or ailerons which have proved quite satisfactory. The firm of Dyle-Dacalan is even making pressed steel members for aeroplanes, and is showing a body built up in this way. In view of the necessity of constructing machines for carrying heavy loads the use of pressed steel is well worthy of consideration. Although weighing no more than a tubular construction pressed steel has the advantage of offering a greater margin of security. In one case, the body or fuselage is made entirely of sheet metal in the shape of a torpedo, and of whatever construction the bodies may be they are nearly all enclosed, so as to offer as little resistance as possible.

While the general tendency is to build compact monoplanes sufficiently rigid to necessitate only a minimum number of stays, and to reduce the resistance as much as possible, there is no probability at the moment of makers falling into the error of a uniformity of type, such as was threatened a year ago. The experience of the past season has shown that there is no machine so manifestly superior to all the others as to allow of its being taken as a settled pattern. The Nieuport is being more or less copied, because it undoubtedly demonstrates the value of a principle of design, but there are others, like the Breguet and Deperdussin, which compared favourably with better known machines in the military trials, and it is evident that there are too many ways of designing aeroplanes to give approximately the same results for makers to restrict their opportunities by copying other machines. So long as makers are unable to get away from the fixed plane and the propeller they depend entirely upon the engine, and in the present stage of the aeroplane everything is subservient to the petrol motor, which must be absolutely reliable if the art of flying is to be at all safe. Until now this reliability has not existed. The aviation motor is an entirely new type, which has had to be created to fulfil particular conditions, and the motor engineer has certainly never been

confronted with a problem so difficult of solution. This reliability is a question of refinement and can only be achieved by working along definite lines. At one time it was undecided whether the engine would be a development of the automobile motor or whether it would be evolved from new principles. This indecision still exists, for while automobile firms are adapting engines to aviation work the number of new aviation motors is constantly increasing, the object being to group together as many air-cooled cylinders as possible so as to give out the greatest power for weight. Such engines raise new difficulties in the way of lubrication and carburation, and it will probably mean a tedious process of improvement and refinement to bring these aviation engines to a suitable degree of reliability. Such engines cannot be a practical success unless they are sufficiently flexible. They should run at a certain economical speed for ordinary flight and be capable of instant acceleration, and should also allow of a throttling down when gliding without risk of being stopped by the braking action of the propeller. Some of the aviation engines are quite incapable of being slowed down at all, and others are only flexible within very narrow limits. So long as propellers are keyed direct to crank shafts the engines cannot run at high angular velocities, and they have consequently to be run with very high compressions. This construction obviously limits the scope for engine improvement. It is for this reason that interest is being revived in the chain-driven propeller, which is favourable to a much higher efficiency. A large propeller turning comparatively slowly is more efficient than a small high-speed propeller, and as in the former case the engine itself can run at a high speed, and under exactly the same conditions as an automobile motor, there is obviously a gain in efficiency and security all round.

The International Steel Trade Situation.

IT is a striking fact that although the situation of the iron and steel industries in Great Britain and Germany in recent years has been largely subject to the influences of the market in the United States, the past twelve months have shown a noteworthy alteration on this side of the Atlantic Ocean. It formerly seemed to be necessary for the iron and steel trades in the United States to experience a period of highly prosperous trade before a favourable reaction occurred in the same branches of industry in Europe. But European producers appear, at the present time at all events, to be less dependent upon the position of affairs in the United States than was the case years ago. The change is all the more remarkable when it is considered that the American market is passing through a period of depression in prices, if not also to some extent in the matter of production and consumption. A comparison of the official inland quotations in the United States shows that rails alone have been maintained on a uniform level in recent years down to the present moment. On the other hand, Bessemer pig iron, steel billets, bars, plates, sleepers, wire nails, and tin-plates are all considerably less than they were a year ago, and they are also lower than they were either in 1902, 1906 or 1908, whilst the average for this range of products indicates a constant decline since 1902. It will be recalled that the collapse in American prices which took place several months ago was brought about by the withdrawal of independent steel producers from the agreements or arrangements which were concluded with the Steel Trust (United States Steel Corporation) on the occasion of the periodical dinners organised by the leading parties associated with the Steel Trust. The object of these gatherings was to maintain prices on a high level, but since the break up of the arrangements in this direction quotations have fallen to what Judge Gary, the president of the Steel Trust, recently declared to be the bottom level, and he is reported to have added that many independent producers, but not the Steel Trust, are now compelled to sell at cost prices. However that may be, it represents the opinion of the president, who does not expect any material advance in quotations in the near future owing to the present political situation and the coming presidential election developments in the course of the next few months.

The position of affairs in Europe, on the other hand, is comparatively more satisfactory than in the United States. In Great Britain the iron and steel trades are well employed on home account, especially in consequence of the great activity prevailing in the shipbuilding industry, and iron and steel makers in general will be able to look back upon 1911 as a fair period of prosperity. It is true the prices might be more favourable from the point of view of producers, but they are subject to the effects of foreign competition from at least three other countries; and it still remains to be seen whether the system of granting a rebate of 5s. per ton to consumers who undertake to purchase British material only, which was recently brought into operation, will be successful in checking the imports of foreign steel. If we now turn to Germany it is found that the situation there is exceptionally favourable at the present time, as that country is passing, temporarily at all events, through a period of high prosperity such as has never previously been attained from the standpoint of the degree of activity. During the past few months the domestic demand in the Fatherland has considerably increased as a result of the general improvement in trade in the country, which particularly affects the shipbuilding, electrical engineering, and other industries, whilst at the same time the extensions of iron and steel works and the erection of entirely new works have also contributed their share towards expanding the requirements for iron and steel. Not only so, but special attention has also been devoted to the cultivation of the export trade, and the German exports of iron and steel and manufactures thereof have now largely surpassed those of Great Britain. Apart from the favourable degree of employment, it is of importance to note that the inland prices, which experienced large declines in some branches in the earlier months of the current year, have recently undergone advances of considerable extent. A general pig iron syndicate has been brought into existence, and has raised domestic prices all round; the quotations for bars, plates and sheets, and wire rods have also been increased, whilst the tube branch, after a period of intensely keen competition, has also begun to improve. The Steel Syndicate stands alone in having made no advance in inland prices in recent months, but the export quotations for semi-finished steel have been augmented by about 10s. per ton since June, owing largely to the pressing demand for home consumption. The export rates for finished iron and steel have also entered on the upward movement, and it may be said that the general situation in Germany is of a highly prosperous character.

The question of concluding an international understanding between iron and steel producers, which aims at the regulation of prices and the division of the world's trade, should now become of peculiar significance to British makers in view of the developments which are proceeding both in the United States and Germany at the present time. Judge Gary, when recently asked for information on the subject of the arrangement, suggested at the Brussels Conference in the past summer, is reported to have stated that nothing had taken place since his departure from Europe. This statement scarcely causes surprise in view of the fact that in the meantime the United States Government has commenced an action against the Steel Trust, with the object of attempting to secure a judgment that it is contrary to law, whilst, notwithstanding this suit, the Committee of the House of Representatives has just decided to continue the inquiry into the methods of the Steel Trust, so as to be able to recommend legislation on the subject. Apart from these matters it has to be borne in mind that the American exports of iron and steel have this year experienced an extraordinary expansion—a development which was deemed impossible in some quarters even a few months ago. For instance, the exports in the first nine months of 1911 amounted to 2,297,000 tons, or 679,000 tons in excess of the corresponding period in 1910, plates and sheets alone representing 1,322,000 tons of the former quantity, as against only 167,000 tons in the same term in 1910. On the other hand, the exports from Germany have risen from 4,000,000 tons in the first ten months of 1910 to 4,380,000 tons in the same months in this year, or an advance of 380,000 tons; but the British exports have declined from 3,959,000 tons to 3,804,000 tons in the same periods respectively, or a reduction of 155,000 tons down to the end of October. If, then, the American and German iron and steel producers have made such large progress as is indicated by the export figures in question, it is scarcely likely that in any attempted division of the world's trade they would be disposed to recede from the position already attained in export markets. The circumstances therefore suggest that if a successful endeavour is to be made to recover lost ground, British iron and steel makers could not expect to accomplish this object by binding themselves to any international agreement if anything further should be heard of the scheme.

Congress and the Panama Canal.

NO words are needed to emphasise the importance of the announcement—which we are to-day enabled to make, on the authority of the Isthmian Canal Commission—that the Panama Canal, its channels and structural and operating works, will be sufficiently complete by July 1st, 1913, to pass with security from ocean to ocean all shipping then claiming transit. As the Commission has pointed out in its latest annual report, and as Mr. Taft reaffirms in a special message recently addressed to Congress, the next move in the matter must be directed from the Capitol at Washington. Repeatedly, during the past few years, Congress has been urged, by friends and critics alike, to indicate its will respecting the future of the enterprise. So far, however, the results have been of quite stereotyped character—a number of Bills introduced by senators and representatives more or less irresponsible; some perfunctory debates, followed by the reference to committee of the already moribund measures; a considerable increase in Uncle Sam's printing and stationery bills; and a corresponding augmentation of "deadhead" literature passed through the mails. Of all the Legislatures of the world there is none, at times, more impulsive than that of the United States; none, on occasions, when faced with a specially knotty problem, or inspired with a spirit of obstinacy, more capricious and dilatory. Thanks to its heedless attitude in the past, it is this session faced with an accumulation of Canal business almost appalling to contemplate, yet demanding—if the material interests of the United States are not to suffer—immediate and deliberate decision. Foremost among the problems, of course, is the question of tolls—the terms upon which the shipping interests of the world are to be invited to make use of the new route, and the discrimination, if any, which is to be accorded to vessels flying the American flag. Other matters calling for prompt attention are the organisations for the future operation of the highway and government of the Canal Zone, the purchase of additional lands required for military and naval purposes and by various administrative departments, and the legislation necessary to give full effect to the traffic regulations tentatively approved by the Commission and President. Excellent, for example, as may be the rule that the Canal authorities shall take control of all vessels during their transit of the locks, there is obviously required, in the interests of shipowners, a corresponding assumption of responsibility for damage on the part of the Government. It is most assuredly in no spirit of hostility to the Canal or to the American people that we urge early settlement of matters so closely touching the commercial and other interests of Great Britain, the Dominion of Canada, and not a few colonial possessions. We believe that the nearer Congress conforms to what has been declared since 1849 to be the "fixed" policy of the United States—namely, its "sincere wish" to see the Canal dedicated "to the common use of all nations, on the most liberal terms, and a footing of perfect equality for all,"—the more certain will be the Republic's prospect of securing an early and adequate return for its vast outlay.

The Engineering Standards Committee.

THE small Committee which, on the motion of Sir John Wolfe Barry, was formed in January, 1901, to consider the advisability of standardising various kinds of iron and steel sections, originally consisted of seven members of the Council of the Institution of Civil Engineers. Since its inception its sphere has been vastly widened until it has grown into the present Engineering Standards Committee. It is now supported by all the leading technical societies, the principal Government offices, and many important manufacturing firms. From standardising steel sections it has extended its purview until practically everything which can be standardised in the engineering profession is included, or about to be included, within its scope. The recognition of the importance of its work is testified to by the annual grant which it receives from the Government, and the financial support accorded to it by numerous public and private bodies. The main Committee, composed of the representatives of the five supporting institutions, is presided over by Sir John Wolfe Barry, and has now under it 13 sectional committees and 27 sub-committees, with a total membership of 321. Since 1901, and down to July, 1911, 54 reports and specifications have been published.

The best indication of the value of the Committee's work is to be found in the extent to which its recommendations are being

adopted. Under this heading in the seventh report, just issued, we find that the Admiralty has adopted the British Standard Specification for steel for marine boilers, as well as that for structural steel for shipbuilding. The specifications for steel castings and forgings for marine purposes have also, with certain additional requirements, been adopted for British naval work. The Board of Trade, Lloyd's Register, the British Corporation, and the Bureau Veritas have all given effect in their rules to the Committee's recommendations in certain marine matters. The specification for Portland cement is being increasingly used, and the material of this class used at the Rosyth naval base has now to be in conformity with the Committee's recommendations. The Railway Clearing House, the War-office, the Indian and Colonial Governments are all employing some one or more of the Committee's specifications relating to railway material. It is interesting, too, to note that in the year ending March, 1911, 70 per cent. of the total weight of tramway rails rolled in this country were in conformity with the British Standard Specification on this subject. The London County Council has had the London Building Acts amended, so as to require the steel and cement used in steel frame buildings to fulfil the conditions laid down in the appropriate British Standard Specifications. It will thus be seen that the reception given to the work of the Committee bids fair to become universal. There need not, we believe, be any fear that the Committee will exercise a tyrannical rule over the engineering manufacturer. We can safely state that up to the present nothing has been dealt with which did not really call for standardisation, and there is no likelihood that the policy of the Committee will change in the future. It is clearly recognised that some things cannot be standardised, and that the manufacture of others, for example, the special steels and steel alloys used in automobile work, is not yet sufficiently advanced to permit of standardisation. It will be welcome news to many of our readers that the Committee is about to issue a report on British Standard definitions for "Elastic Limit" and "Yield Point." Another interesting subject foreshadowed is a report from the Sub-committee on Keys and Keyways, dealing with the influence on the standard keyways and keys of rapid reversals of stress.

LITERATURE.

Structural Engineering. By Joseph Husband and William Harby. London: Longmans, Green and Co., 39, Paternoster-row.

In the last three years there have appeared several books on structural engineering written with the expressed purpose of bridging the gap between the study of the theory of structures and their practical application. The present volume is a remarkably complete work of this kind, and, while not containing much that is absolutely new, provides a vast amount of information useful to engineering students seeking a knowledge of the principles of structural engineering and to engineers and draughtsmen engaged upon construction and design. The ground covered being so extensive, it is not possible to notice all the matters of interest dealt with, and we can only attempt to mention some of the points which distinguish the work from others of its kind. The headings of the different chapters will give some idea of the variety of subjects treated. It has been the aim of the authors to subordinate the theoretical side of the subject and to emphasise considerations which determine the practical design of structures. Much of the matter in Chapter I. on "Materials" has thus been given in specification form. The manufacture and testing of cement and the mixing of concrete are briefly described, and some information given concerning asphalt. We miss any reference to the extensive use of carbolineum for preserving timber, although various other methods are described. In Chapter II., on "Loads and Working Stresses," the weights of various roofing materials will be found useful, but the live loads given for railway underbridges are somewhat misleading. Two types of locomotives are illustrated, one a Great Northern Railway engine of the "Atlantic" type, the other a Great Western Railway engine of the "Consolidation" class. These are described as "the types of locomotives which produce the heaviest equivalent distributed load at present (1911) in use on English railways," and these equivalent loads increased by 2½ per cent. are tabulated. The engine diagrams and the table have evidently been taken from the paper presented by Mr. A. Ross before the Engineering Conference of the Institution of Civil Engineers held in 1903, and also published in the Engineering Press, but at the present time there are several engines running, which produce higher equivalent distributed loads than those tabulated without the addition of 2½ per cent. A noteworthy feature of Chapter III., on "Bending Moment and Shearing Force," is the extensive use made of the characteristic points for obtaining the bending moment diagrams for continuous beams and beams with fixed ends, and in view of the frequent occurrence of these conditions in beams of reinforced concrete, this portion of the book will prove especially useful to those engaged in the design of structures in this material. The authors' sound treatment of the shear stress in "Beams," Chapter IV., is also worthy of mention. Euler, Rankine, and straight-line formulæ for the safe load on "Columns and Struts" are referred to in Chapter V., but prominence is given to Mr. J. M. Moncrieff's investigations described in a paper presented before the American Society of Civil Engineers in 1900. Mr. Moncrieff's formulæ are exceedingly complicated, but they have the advantage of being constructive in form, and give the value of the radius of gyration of the section required to keep the working stress in a column, to suit given conditions, within the prescribed limit. The examples to illustrate the design of "Plate Girders," Chapter VI., are very happily chosen, and include girders of 60ft. span supporting the travelling crab of a 25-ton crane, and the girders of a double-track railway bridge of 80ft. span, consisting of rail-bearers, cross girders, and two main girders. A lattice crane girder is also described, and the stresses worked out in the following chapter on "Lattice Girders." Only analytical methods of determining the stresses in the various types of lattice girder are given, but these are simply and clearly described, and are in very common use in practice. The calculated "Deflection" of lattice girders and beams with solid webs is determined in Chapter VIII. by equating the work done by the applied loads to that done by the internal forces. "Roofs" form the subject of Chapter IX., and various types are considered. Here graphical methods of determining reactions and stresses due to dead load and wind pressure are described, but the analytical method of sections is also made use of. There is a lot of useful information and details in this chapter, and the subject is carried over into the following chapter, which commences with the design of a lattice roof girder, and deals also with the design of a crane jib, a steel tank, and the general principles relating to the construction of tall buildings.

The final Chapter XI., on "Masonry and Masonry Structures," forms in itself an excellent little treatise on this subject, and covers some 70 pages. The early part deals with construction in various classes of masonry and brickwork, and the latter part with the design of foundations, retaining walls, dams, arches, and tall chimneys. A graphic method of determining the magnitude of the earth pressure behind a retaining wall, due to Professors Rebhann and Häseler, and much used on the Continent, is described, and gives results which agree very well with established practice. The section on dams is illustrated by diagrams and descriptions of many of the larger dams, and that on arches by such well-known examples as the Luxembourg arch. Only graphic methods of obtaining the line of resultant pressure in pin and rigid arches are given, Professor Fuller's method being applied to the case of the rigid arch. The design of a skew arch bridge is worked out for an angle of skew of 23½ deg. This gives one rather a shock until the realisation comes that this angle is the complement of that usually referred to in practice as the angle of skew.

There are close on 400 pages in the book, and nearly as many illustrations. The authors have faithfully adhered to their purpose to avoid the use of advanced mathematics, except in one or two cases, where the desired result could not otherwise be obtained. The several references to crane girders and gantries are particularly opportune at this time, when the manufacture of lifting plant has received such decided stimulus. The work has certainly much to commend it to engineering draughtsmen. In earlier years students were recommended to use the more classical works on the theory of structures treated as a branch of applied mechanics; and there are still many who, with good reason, pin their faith on the supreme value of pure theory as the basis of engineering education, to be followed by a course of practical training. The several works on structural engineering which have appeared within the last few years, written for the most part by members of the staffs of one or other of the technical colleges, each one showing a more decided leaning towards the practical side of the subject, are not the only indications of changing views in this respect, rendered necessary possibly by the comparatively short time the average student is able to devote to his education and training. It is a significant fact, too, that as the book becomes more practical, so does the price become such as to bring it more within the reach of every man.

Electric Crane Construction. By Claude W. Hill. London: Charles Griffin and Co., Exeter-street.

THE advent of the electric crane has been the means of giving rise to the need for electrical knowledge on the part of crane designers, but it is probable that there are few who have thoroughly mastered both sides of the subject. The author of this work, however, is an engineer who has devoted his energies to all the problems involved, including those connected with the design of somewhat novel structures, and it will, perhaps, be remembered that he was largely responsible for the evolution of the Flip-Flap at the White City.

The book, it is stated, has been written for engineers engaged in the design and construction of electric cranes, and for those who require to erect, test, and use them. It is based chiefly on notes and data compiled by the author in the course of his practice, and this being so, the reader has the satisfaction of knowing that the formulæ given have been put to the test of practical application. Little has been done in the way of working through complete examples and giving test figures, but we should mention that many drawings are included which will undoubtedly interest those engaged in this particular branch of engineering, In places Mr. Hill has provided some useful information which has been derived from actual tests, but we are of opinion that more should have been done in this direction.

In the chapter on the power required for electric cranes the author's experience as to the efficiency of various cranes might have been placed at the disposal of his readers. An interesting table is included in this chapter giving an analysis of the losses in a 30-ton crane, and also some recorder curves showing the current intake of a 5-ton crane when performing various operations. We consider that more information of this description, together with full particulars of the cranes to which the test figures refer, would add to the value of the book materially. Some useful hints are given in the chapter on the design of crane machinery, and particularly with reference to the design of shafts, bearings, keys and tooth gearing. The latter, however, is more fully treated in a subsequent chapter. Here we should state that in dealing with the design of machinery the author considers the question of deflection, as the deflection of shafts or of the structure supporting them, is liable to lead to excessive transmission losses and to noise and excessive wear in tooth gearing.

Seven chapters are devoted to descriptions of the principal types of cranes. The stresses and other points peculiar to each type of crane are also considered, and drawings of typical cranes are given. Test figures are included in some cases.

Some tables giving the breaking loads of British standard steel sections when used as struts should prove of considerable value to crane designers. In considering girders the effect of rolling loads is emphasised with a view to showing that the maximum stress does not occur on all the members when the load is in the position which gives the maximum bending moment, and that it is therefore necessary to take out the stresses for different positions of the load.

The book has references to overhead cranes, locomotive and portable jib cranes, derrick cranes, transporters, sheer legs, revolving cantilever cranes and cableways. From the mechanical engineer's standpoint the chapters on the design of crane structures and tooth gearing are undoubtedly the most important, whilst electrical men will probably find the chapters devoted to the design of magnets, motors, controllers and collectors, and crane installations the most interesting. In dealing with brakes, the forms mostly used are described, and calculations for their design are given. Some space is devoted to showing the method of ascertaining the pressure per square inch between the frictional surfaces of hand brakes, this being an important point which has to be considered in connection with their design. The chapter on the design of magnets is very clear and concise, and with the aid of the simple formulæ given engineers should experience no difficulty in arriving at the dimensions and the ampère turns for any given magnet. In considering motors for crane service the author deals with the subject of testing, and expresses the opinion that continuous runs are preferable to the more complicated methods. Towards the end of the chapter dealing with crane motors the author points out that alternating current motors of the polyphase type as at present made are not so suitable for crane work as direct-current machines, on account of their want of flexibility in speed. Whilst this is true of the ordinary induction motor, the fact should not be overlooked that there are such things as commutator polyphase motors, the speed of which, it is claimed, can be changed in a simple, convenient and economical manner. We have no knowledge of these having been used for crane service, but the fact remains that one of the large German electrical engineering firms supplies these motors for use in connection with driving machines which require a wide speed variation.

We are afraid that readers who are not over well versed in electrical matters will have some difficulty in understanding what the author means when he says that "the polyphase motor has the same property as a shunt motor of generating current if *overhauled* by the load." It would have been far better to have said that the polyphase motor returns current to the line when the speed of the rotor is increased above the synchronous value.

The two last chapters of the book have reference to controllers and collectors, and crane installations. In the former useful formulæ are given for the calculation of controller resistance, which should prove of service not only for designing controllers, but for checking designs submitted by controller makers. In considering crane installations Mr. Hill deals with the question of types of cranes, employment of accumulators on crane circuits, and so on. It is obvious, however, that this section of the subject cannot adequately be considered in a single chapter. The book is well worthy of perusal by engineers interested in electric cranes, whilst students and others desirous of gaining general information concerning gearing, the design of crane structures, &c., and of acquiring general knowledge relating to electric motors, controllers electro-magnets, and so forth, should also find it of value

A Manual of Civil Engineering Practice. By F. Noel Taylor, C.E., M. Inst. M.E. London: Charles Griffin and Co., Limited. 1911. Price 25s. net.

THIS is a volume of over 800 pages, containing 1179 illustrations and 35 folding plates, and it is designed to meet the needs of young engineers who are preparing to occupy positions of responsibility, such as municipal and county engineers, borough surveyors, &c. It deals with the general practice of municipal engineering work and the theoretical principles involved therein, and includes such subjects as design of structures in brick, stone and reinforced concrete, chimneys, steel construction and mechanical engineering, roads, electric tramways, bridges, river work and land drainage, hydraulics and pumping machinery, waterworks and sources of supply, sewage disposal, sanitation, and refuse disposal, &c.

We have gone through the work with considerable care, and have been surprised to find how wise a selection has been made by the author in the various subjects dealt with. The work is not an encyclopædia, nor can it, of course, claim to be a text book upon all the varied subjects treated, but as a book of reference, and as an introduction

to the various text-books upon special subjects, it would be difficult to beat. In many cases the author gives at the end of the chapters a concise bibliography of works which deal with the special subjects. In the earlier portion of the volume Ordnance maps are described and contours explained, and examples of pages from actual field books are given. The theodolite is described and its uses explained, and simple traverse surveys dealt with. While on the subject of levelling, the author gives very practical notes as to entering the readings in the field book, and illustrates his remarks by an actual example of his own work for a proposed bridge and weir at Bray. It may be said, in passing, that many examples are taken of Irish practice, which is quite natural, seeing that the author's work has been done in that country.

Useful data are given from practice regarding timbering of trenches and the equalising of embankments and cuttings, and the author shows how this is done by first getting an approximate line and then taking cubes of the volumes to be removed and added, and by this means rectifying the line.

In Chapter VII., dealing with the Mechanics of Engineering, the testing of materials is described and the method of making stress-strain diagrams. When considering the design of engineering structures the author notes that steel construction is usually left to the contractor, but masonry, brick, and concrete is placed in the hands of the borough or county engineer. He quotes a paper by Professor Genese, of University College, Wales, on "The Standardisation of Formulæ in Engineering," where he cites the various forms in which Gordon's formula for columns appears in different text-books. It is most desirable to secure some standard system for formulæ. We have often spent time in obtaining results by two formulæ which were very different in outward appearance, but on closer examination turned out to be some well-known formulæ masquerading under different nomenclature. With reference to materials of construction, after describing briefly the rotary kiln system of producing Portland cement, the author says that Roman cement made from the septaria nodules in London clay is unequalled for jointing sewer pipes, but in a footnote very wisely adds:—"This statement is open to criticism, as many leading engineers now use Portland cement, especially with 'Stanford' joints."

After describing the method of bonding brickwork he alludes to Kubelka's method of hardening soft stone by saturating it with a solution of potash or soda water-glass, followed by impregnation with molten chloride of calcium, but he does not cite any actual cases where he has personally used it with satisfactory results.

Under the heading "Constructional Carpentry" he refers with great approval to the timber footbridge built of English oak over the river Wey at Guildford at a cost of £400 and opened in August, 1909. A very good account is given of the latest methods of making tar macadam roads.

Reinforced concrete has a special chapter devoted to it, and various methods of floor construction are described fully; whilst sewage disposal, under various systems, is discussed, and the report to the Local Government Board upon the Salford Sewage Works is given in full.

Near the end of the volume notes on specifications are given. These are, of course, merely outlines, and we were reminded of Macey's "Specification in Detail," which deals with a similar subject from the architectural point of view, and, of course, in a much more detailed way. The appendices are very valuable; details of the regulations of various public bodies are quoted, and then an example of general conditions of contract is given. We have often wondered why the Institution of Civil Engineers did not issue an approved form for such condition. For many years the Royal Institution of British Architects has published such a document, which is very widely used, but is not fully applicable to engineering works, although in some cases we have known it so used. The work is thoroughly well printed and particularly well illustrated.

Tables of Physical and Chemical Constants, and some Mathematical Functions. By G. W. C. Kaye and T. H. Laby. London: Longmans, Green and Co., 39, Paternoster-row.

THE title of this volume is so explanatory of its contents that we need say hardly anything descriptive of it. It may perhaps be of advantage if we describe the book as a modified form of the well-known Smithsonian Physical Tables. In passing we note that the preface to the volume, like that to the Smithsonian Tables, acknowledges the indebtedness of the compilers to the Physikalisch-Chemische Tabellen of Landolt and Börnstein. The present volume is divided into nine sections, as follows:—General physics, astronomy, &c.; heat; sound; light; electricity; magnetism; radio-activity and gaseous ionisation; chemistry; mathematical tables. A very complete index closes the work.

The volume is not a mere collection of tables. Interspersed between the numerical and other data we find numerous little paragraphs and reference notes. These, together with the tables, may be regarded as the fruits of physical science presented in a condensed form. But the process of condensation, while serving a most valuable utilitarian purpose, has not eliminated all readable interest from the volume. There are many curious and perhaps little-known facts to be found on record in the pages of this book. There are now, for instance, eighty-one substances recognised as elements. The latest comers are europium, dysprosium, and lutecium. Again, liquids, if free from air, can sustain considerable tensile stresses without rupture. Thus, the tensile breaking strength of water is about 70 lb., and of alcohol about 170 lb. The human ear is not usually considered an extraordinarily sensitive instrument. That it really is is shown by the fact that a normal ear can respond to a variation of pressure—and it is, of course, our perception of a variation of pressure on the drum of the ear that produces the sensation which we call sound—of about 4×100^{-7} mm. of mercury, or, say, 77 ten thousand millionths of a pound per square inch. It can perceive, too, intervals of time as short as seven-thousandths of a second. The extreme range of the ear is about eleven octaves, but of these only about seven are musically available. At the present moment a remarkable variation is taking place in the value of H, the horizontal component of the earth's magnetic field. For generations this quantity has been steadily increasing all over Western Europe. During the last ten years, however, a wave of depression has set in from the East. Since 1900 H has been falling at St. Petersburg. In 1905 the decrease was first noted at Potsdam. Greenwich and Kew began to experience it in 1907. But at Falmouth and Valencia in 1909 H was still increasing. Tucked away in an odd corner of the book we find, what may be news to some of our readers, the statement that, while a British billion is a million millions, a continental billion is only two millions. A British trillion is a million million millions, but abroad it is only three millions. We may add ourselves that the United States convention in this matter is the same as our own.

We could go on extracting little pieces of interesting news from the volume, but the above must serve. The book is, of course, a work of reference, but we have tried to show that it may also yield information of the most interesting kind. We have only one fault to find with the volume. We regret that its covers, instead of being limp cloth, were not made of a more protective material.

Oil Fields of New Zealand. By J. D. Henry. With Maps, Diagrams, and Illustrations. 4to. Pages 26 and 337. Bradbury, Agnew and Co.

MR. J. D. HENRY is a prolific contributor to the literature of the petroleum industry, and has produced the present volume within a few months of his return from a journey round the world. It is a companion volume to the author's "Oil Fields of the Empire," which appeared only a year or so ago, and like it, is got up in a somewhat fanciful style, which can scarcely be regarded as adding to the utility of the work; the pages measure 10in. by 7½in., with deep margins, and interleaved with them are coloured sheets bearing illustrations, &c., as well as other pages, with scrappy notes set up in odd ways, some with fantastic borders. The matter is dealt with in twenty-three chapters and sundry introductory notes arranged in three parts. Part I. deals with the Taranaki oil district in the west coast of the North Island; Part II. with the fields of Gisborne and Wairapapa on its east side; Part III. with the South Island oil areas of Kotuku, Cheviot, and Canterbury plains, and the shale oil deposits at Orepuki. The information consists chiefly of reprints of official and other reports, interspersed with crisp passages and comments by the author. The story told is full of interest, and in places clearly shows what may be achieved by keen patriotic men with indomitable persistence in the face of enormous difficulties and many disappointments; as is pointed out, "the fact is not generally known, and many will be surprised to learn that the history of New Zealand oil goes back to 1865, and it would be difficult to "find a more interesting story of the subordination of commercialism to local patriotism and an exhibition of colonial loyalty to industrial projects calculated to work to the common good of the people" than that shown by the New Zealand oil pioneers. It is pleasant to gather that their efforts and those of their successors are likely to find a satisfactory reward in the establishment of productive oil fields in New Zealand. It is also interesting to note that the Government is giving admirable support to the movement through its Geological Survey Department. Much of its information is included in this volume in spite of a slight tendency not to take the geologist at his own estimation.

We should imagine that there can be little information relating to the subject that has not been taken into consideration by the author, and the resultant volume now before us should prove of great use to those in search of information on this important subject.

The Principles of Electric Wave Telegraphy and Telephony. By Professor J. A. Fleming, M.A., D.Sc., F.R.S. Second Edition. London: Longmans, Green and Co.

THE title of this book is somewhat modest. It is really a sort of storehouse containing all the information that anyone could possibly want on the subject; in fact, some that nobody could want. We have here the work of a writer whose mathematical equipment enables him to discuss not only with great fulness, but also with great clearness of exposition, what is generally known as the theory of the subject, and at the same time we have a writer who has himself a good practical acquaintance with his subject, and an enormous knowledge of the literature of the art. The result is an encyclopædic volume.

There are many difficulties in the way of the author who wishes to write a good book on such a subject as wireless communication, because it is not only exceedingly difficult in itself, but the information as to what is actually being done is not public. Of course, an author may have recourse to patent literature, but the laws of Nature are not always quite the same in patent specifications as in fact. Newspaper accounts, and even those of technical journals, or at least some technical journals, are not always quite trustworthy either. Dr. Fleming has used very great discretion in tackling this difficulty. He quotes a large number of specifications as such, so that the reader can estimate their value in accordance with his past experience of that form of literature. The writer of a work like this is also at a disadvantage, because the industry is growing, and the progress of invention is very rapid, an extraordinary number of very able men being now attracted to Wireless, as there seems to be much more room for invention in it than anywhere else. Dr. Fleming has made his book as up to date as it well can be, and no doubt in course of time there will be some new editions or supplements. It has already made its place as a standard book on the subject, and we know of no work to compare with it in this or any other language.

SHORT NOTICES.

A Handbook on the Gas Engine, comprising a Practical Treatise on Internal Combustion Engines. By Herman Haeder. Translated from the German and edited by W. M. Huskisson, with the addition of numerous useful Tables and other matter. London: Crosby Lockwood and Son. 1911.—This is a kind of *vade mecum* for the internal combustion engine draughtsman. After discussing with the help of diagrams the various types of gas engines, it undertakes the study of the stresses in every part and shows how they are to be calculated. All this is laid out in tabular form and with thorough German painstakingness and attention to detail. After perusal one feels that anyone with an education no higher and no more specialized than the sixth standard could design you as many engines as you please. It is at the drawing board that the weakness and the strength of such books as this are revealed. It is true that there are many things which no book can teach, whilst on the other hand, there are many things which it is easier and more economical to take from a book than to store in the brain. Why the volume should end with a series of sixty-seven questions we are at a loss to understand, unless the intention is to encourage the student to think that he knows all about the subject, for it is hardly conceivable that anyone with an elementary knowledge of the subject could be "ploughed" by this simple examination. However, that is by the way. Taken as a whole, and provided the accuracy of the formulæ is high, it should be a serviceable book to the designer.

The Calorific Power of Gas. By J. H. Coste. London: Chas. Griffin and Co., Limited, Exeter-street, Strand. Price 6s. net.—The adoption of incandescent gas lighting and the increasing use of gas as a source of power have largely discounted the value formerly attached to the testing of gas for its illuminating properties. Instead of expressing the quality of the gas as so many candles per cubic foot, it is becoming more and more common for all purposes to judge the material by its calorific power. It is therefore of some importance to have a book such as the one before us dealing exclusively with the measurement of this quantity. Having considered calorific standards, the author deals with the composition and properties of coal gas and similar gaseous mixtures. He then gives a very full account of the numerous instruments invented for the purpose of determining the calorific value of gases, discusses their use, and criticises their liabilities to error. The book should be of the greatest value to all chemists and engineers interested in any way in the use of gas either for illuminating, heating, or motive purposes. We may remark that the author is in some doubt apparently as to the spelling of William Murdock's name. In the text it is spelt with a "k,' but in titles to illustrations and in the index it is spelt with an "h." The final letter is, of course, a "k," as Mr. Coste can easily verify by referring to the autograph letter published in our issue for December 17th, 1909.

The Calculation of Columns: A Practical Application of the Theory. By Theodor Nielsen. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. Price 4s. 6d. net.—In this useful little book the author records formulæ for determining the strength of columns as deduced by Professor Ostenfeld, of Copenhagen, from the numerous tests carried out by the late Professor Tetmajer at Zürich. Factors are first given for determining the "free length" between two consecutive points of contraflexure of columns with ends held in various ways, and it is this "free length" which enters into all the subsequent formulæ. Professor Ostenfeld finds the late Professor J. B. Johnson's adaptation of Euler's formula, with constants giving lower results, best suited to interpret the tests for mild steel and wrought iron columns and a Rankine formula for the tests on cast iron columns, and reduces these to a convenient form for arriving at the cross-sectional area of columns to suit given conditions. Built up columns, eccentrically loaded columns, and columns affected by bending moments are also considered. The author has in many cases converted the metric values of constants recommended by Professor Ostenfeld into British units, and gives tables of calculated breaking loads in tons and pounds per square inch for mild steel, wrought iron, cast iron, and pine columns of various lengths in relation to the least radius of gyration.

BOOKS RECEIVED.

Who's Who, 1912. London: A. and C. Black, Soho-square. Price 10s. net.

Model Steam Engines. By Rev. J. Shores. Newcastle-on-Tyne: A. Reid and Co., Limited, Akenside-hill.

Post Office London Directory. 1912. London: Kelly's Directories, Limited, 182-4, High Holborn. Price £2.

The Englishwoman's Year Book and Directory, 1912. London: A. and C. Black, Soho-square. Price 2s. 6d. net.

Mining Mathematics. By S. N. Forrest. London: Edward Arnold, 41 and 43, Maddox-street, W. Price 4s. 6d. net.

The Helicopter Flying Machine. By J. Robertson Parker. London: *Aeronautics*, 3, London-wall-buildings. Price 3s. 6d. net.

Automatic Recording Instruments. Reprinted from *The Mechanical Engineer.* Manchester: The Scientific Publishing Company. Price 3s. 6d.

Mining without Timber. By Robert B. Brinsmade. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 12s. 6d. net.

Business Prospects Year Book, 1912. Edited by J. Davies and C. P. Hailey. Cardiff: The Business Statistics Company, Limited, 12, James-street. Price 5s. net.

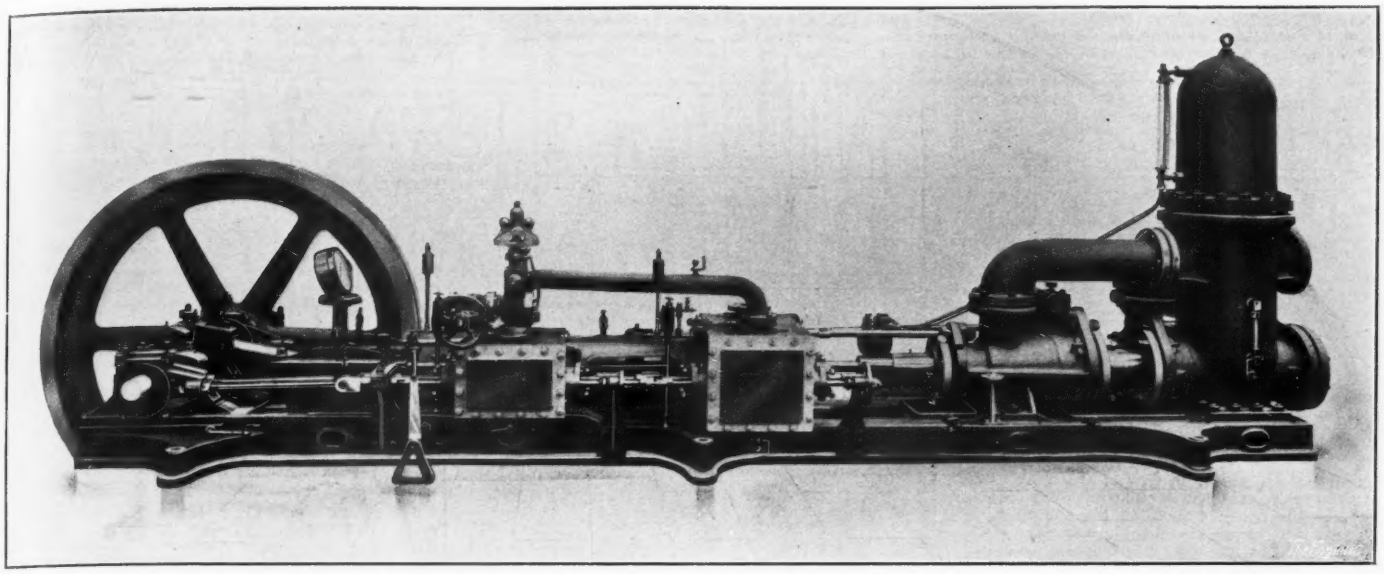
The Concrete Institute, Transactions and Notes. Vol. III. London: The Concrete Institute, Denison House, 296, Vauxhall Bridge-road, Westminster, S.W.

How to do Business by Letter and Advertising. By Sherwin Cody. London: A. Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price 5s. net.

Refrigeration, Cold Storage, and Ice-making. By A. J. Wallis-Tayler. Third edition. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 10s. 6d. net

COMPOUND TANDEM STEAM PUMPING ENGINE

ANDREW BARCLAY, SONS, AND CO., LIMITED, KILMARNOCK, ENGINEERS

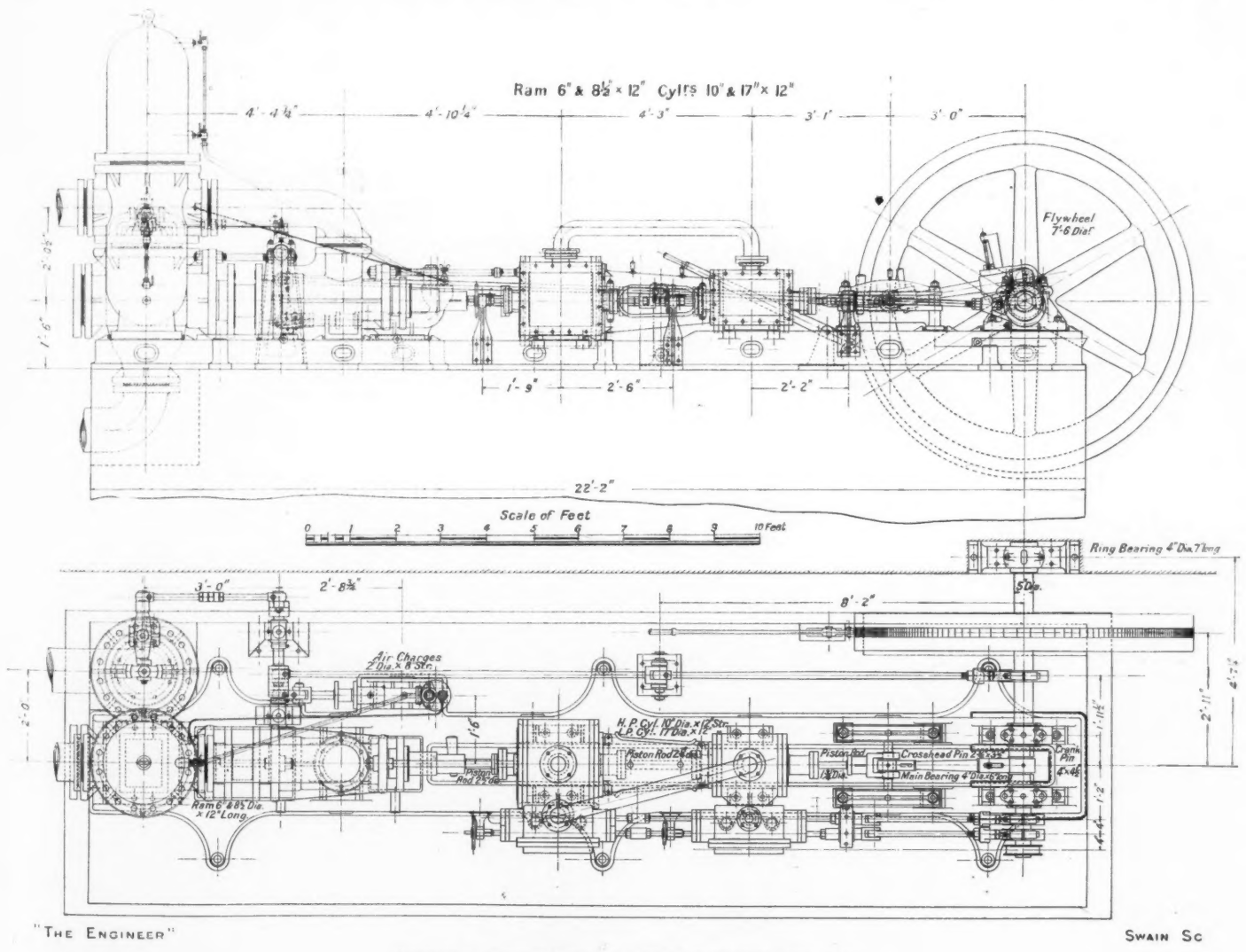


PUMPING ENGINES FOR THE WAR DEPARTMENT.

TWO sets of compound tandem pumping engines have recently been supplied by Andrew Barclay, Sons and Co., Limited, of Kilmarnock, to the War Department. On this page we give a general view and a drawing of these engines, and from these the principal features of the set will be gathered.

The high-pressure steam cylinder has a diameter of 10in. and the low-pressure a diameter of 17in., the stroke being for each 12in. The steam pressure is 160 lb. per square inch. The pumping end of the set is directly coupled to the engine piston-rod and involves a differential pump ram of 6in. and 8½in. diameters with a stroke of 12in. The steam engine is fitted with Meyer cut-off valves on both cylinders, each valve being separately adjustable. The engine governor is arranged to regulate the speed to within 5 per cent. of the required figure. If the speed exceeds 10 per cent. above the mean the governor cuts off the steam supply and completely stops the engine. The fly-wheel fitted to the engine crank shaft is balanced and is exceptionally heavy. The pump proper is of the Oddie Barclay type, and is provided with controlled suction valves and air-charging apparatus. It is arranged to draw its supply either from an elevated tank or from a well.

The set has two duties. At 150 lb. pressure and 105 revolutions per minute its capacity is 15,000 gallons per hour. At 100 lb. pressure and 70 revolutions its capacity is 10,000 gallons per hour. Under test, we are informed, the engines ran very steadily, governed well and when the speed was forced up to an excessive amount the cut-out on the governor acted rapidly. On both duties the pumps ran quietly. The steam consumption, the makers inform us, was approximately 21 lb. per indicated horse-power hour.



"THE ENGINEER" SWAIN SC

COMPOUND TANDEM PUMPING ENGINE—ELEVATION AND PLAN

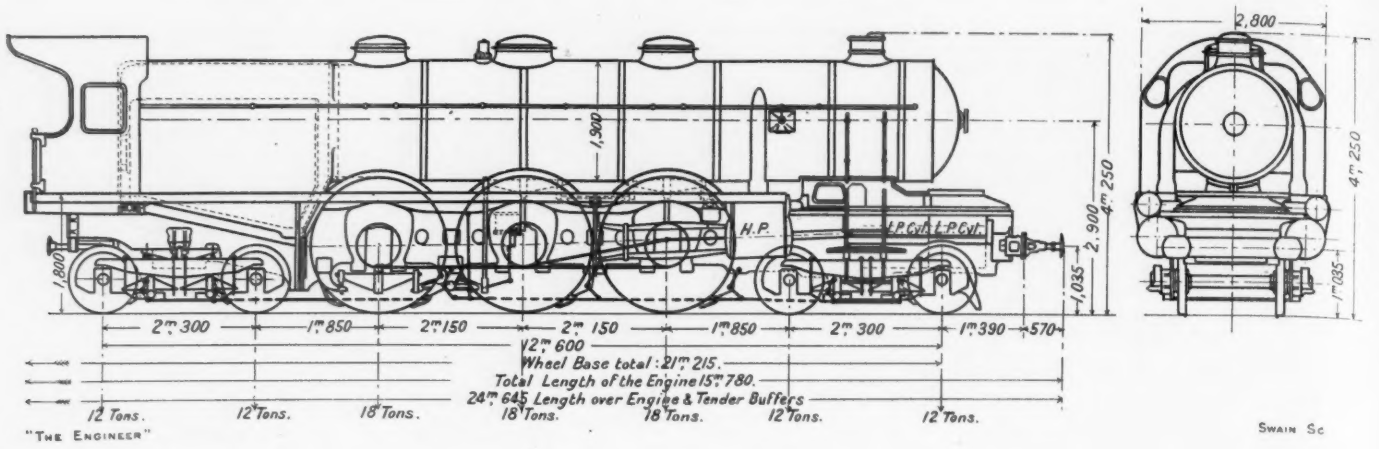
"BALTIC" TYPE LOCOMOTIVES AT WORK.

IN a recent editorial article commenting on the possibilities of the new "Baltic" engines of the French Northern Railway, we mentioned the absence of particulars concerning the weights, &c., of the engine, illustrated on page 241, but now, through the courtesy of Mr. Asselin, we are able to give the general dimensions, together with a new drawing of the "Baltic" engine with the ordinary Belpaire type of boiler.

The other engine has a du Temple water-tube boiler. Both the new "Baltic" engines are now operating the ordinary fast express trains, but as they have been such a short time in service and comprise so many distinctly new features, it is not at present possible to make any statement as to their potentialities.

Moreover, when fully equipped for the extra heavy trains with which they will be required to deal, they will have

CHEMIN DE FER DU NORD, BALTIC LOCOMOTIVE



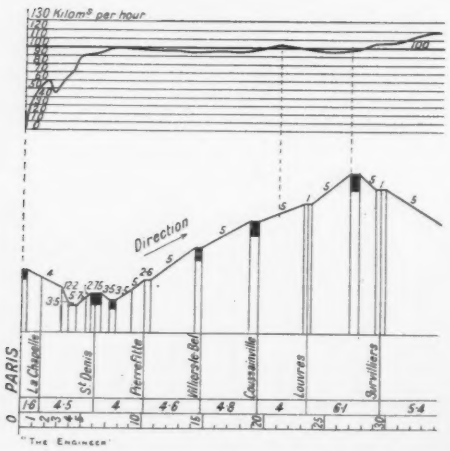
mechanical stokers, which, in view of the slack used, is calculated to effect a considerable coal economy and increased boiler efficiency by reason of the continuous and regular feed, and by preventing the cold draughts which strike on the tube plate and superheater when the door is opened every two or three minutes to fire with a shovel.

The new engines are the same weight as the Belgian "Pacific" type simple engines, Class 10, and 8.8 tons heavier than the P.L.M. "Pacific" type simple engines, but they do not exceed the axle load of 18 tons reached in these two simple types, and are considerably lighter in this respect than recent British engines with four cylinders and six driving wheels.

The "Baltic" engines have the distinct merit of light weight relatively to their great power, the starting tractive effort, even with driving wheels of 82⅝in. diameter, being close on 20 tons.

The boiler power of these engines much exceeds that of the "Pacific" types. Of the two "Baltic" engines, the ordinary locomotive type boiler has the less heating surface, this being 46.55 square metres, or 501 square feet less than in the du Temple water-tube type. Including the superheating surfaces, the total heating surface in the boiler is, in No. 3.1101, 4150 square feet. In No. 3.1102, which has a water-tube boiler, the total heating surface is still more, being 362.29 square metres—or 3898.7 square feet—for water surfaces, and 70 metres—or 753.7 square feet—for steam heating surfaces; total, 4652 square feet. This differs from the figures previously published from the provisional specification, which gave only 62 square metres for superheating surfaces. This is now given as 70 square metres, or 8 square metres more than in the simple expansion "Pacific" engines of Belgium. The steam pressure is 227 lb., or 29 lb. higher than in the latter.

Of the capacity of the "Baltic" engines to haul 400 tons up gradients of 1 in 200 at 60 miles per hour, according to the programme, there appears very small doubt. The preceding "Atlantic" type engine with water-tube boiler can pull regular



SPEED AND PROFILE, PARIS TO SURVILLIERS

trains of 330 tons up long grades of 1 in 200 at 60 miles per hour average, as shown by the annexed reproduction from the speeds automatically recorded. The actual load here shown was 328 tons, or 18 per cent. less than 400 tons.

To provide the power to haul at the same speed on grades of 1 in 200 this 18 per cent. extra load, the "Baltic" type engines have up to 27 per cent. more heating surface and 30 per cent. greater tractive effort in compound working.

The new engines have their steam superheated up to about 350 deg. Cent. temperature, and so benefit by the increased volume of that temperature, an augmentation of boiler power, solely, which adds absolutely nothing to the cylinder efficiency, but, on the contrary, actually appears to reduce the amount of power developed from a given initial pressure in the cylinder at a given cut-off and number of strokes per minute; the lower power output with the superheated steam, under identical working conditions, and as indicated in the cylinders and recorder at the drawbar, varying from 10 to 22 per cent., as was clearly shown in the recent tests of the two forms of steam in the compound locomotives of the P.L.M. Railways; the great economy in the boiler being therefore partly realised at the expense of the cylinders.

General Dimensions, "Baltic" Type Engine with Ordinary Locomotive Type Boiler.

Cylinders*—	
High-pressure, diameter	0.440 m.
,, stroke	0.640 m.
Low-pressure, diameter	0.620 m.
,, stroke	0.730 m.
Drive wheels, diameter	2.040 m.
Boiler pressure, maximum	16 kilos. per sq. cm.
Receiver pressure, maximum	7 kilos. per sq. cm.
Tractive effort, maximum, simple expansion	19,430 kilos.
,, ,, ,, compound expansion	14,710 kilos.
Difference	= 24 per cent.
Grate—	
Length	2.610 m.
Width	1.640 m.
Area	4.28 sq. m.
Fire-box—	
Height from grate, in front	1.925
,, ,, behind	1.490
Tubes—	
34, outside diameter	55 mm.
97, outside diameter	65 and 70 mm.
27 sup: heat, outside diameter	133 mm.
Length between tube plates	6.000
Total area for passage of gases	0.5581 sq. m.
Heating surfaces—	
Fire-box	19.14 sq. m.
All tubes	296.60 sq. m.
Superheating pipes	70.00 sq. m.
Total	385.74 sq. m.
Boiler capacity—	
Water	8.850 cub. m.
Steam	4.340 cub. m.
Total	13.190 cub. m.
Horse-power of boiler	2160 horse-power
Engine wheels, bogies, diameter	1.040
Weights—	
On six drivers	54 tons
On two bogies	48 tons
Total, fully loaded	102 tons
Engine, empty	92 tons
Braking coefficient	74 per cent.

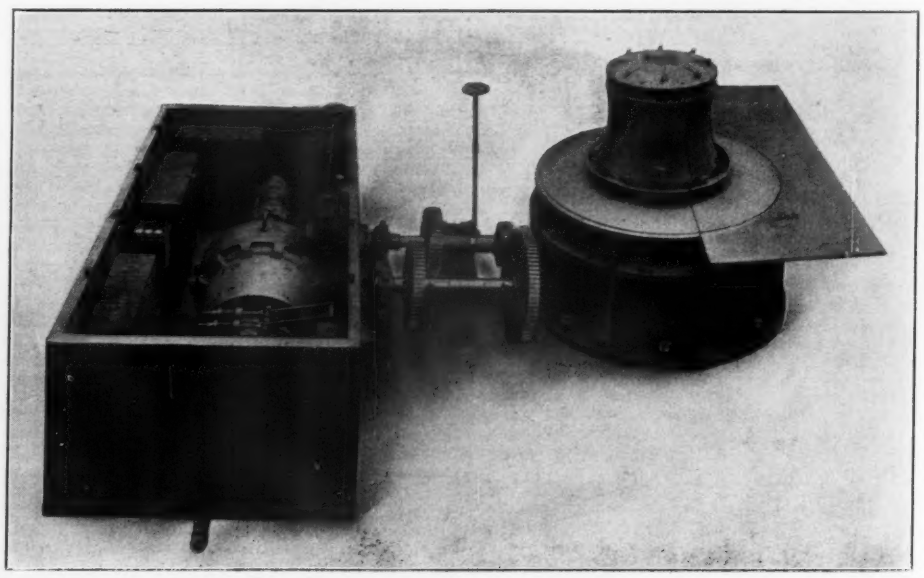
Tender.

Capacity—	
Water	26 tons
Coal	7 tons
Weight on both bogies, fully loaded	2 × 28.25 = 56.5 tons
Tender, empty	23.5 tons
Braking coefficient	35 per cent.

* Cylinder arrangement illustrated page 566, November 25th, 1910.

LARGE ELECTRIC CAPSTANS.

THERE have recently been constructed by the firm of Vaughan and Son, Limited, Royal Ironworks, Manchester, two exceptionally large electrically-driven capstans for ship warping service, which present several features of interest. They are intended for warping into or out of dock vessels of the heaviest displacement now afloat, and they are able to give direct pulls off the barrel of 20 tons and 15 tons respectively, at the rate of 40ft. per minute. The larger of the two capstans is claimed to be the most powerful of its kind yet built.



20-TON ELECTRIC SHIP WARPING CAPSTAN

The accompanying illustration reproduced from a photograph taken in the works of the makers gives a good idea of the general arrangement of one of the capstans, it being, of course, understood that, when fixed in working position, everything is below ground level except the capstan barrel and the controlling spindles. The plating shown at the right-hand side of the picture is extended to cover all the other parts, which, with the exception of the water-tight tank containing the motor and electrical equipment, are enclosed in a brick chamber built on top of the foundation. The illustration, however, hardly conveys a true idea of the size of the machines, which will be better realised when it is mentioned that the total weight of the 20-ton capstan complete is 35 tons, the capstan barrel is 3ft. 7in. in diameter at top and 4ft. 2in. above ground level, while the motor tank measures 13ft. 4in. by 7ft. by 5ft. 3in. Motion is transmitted from the motor to the capstan barrel through a train of worm, spur, and bevel gearing. The worm reduction is coupled directly to the motor shaft, and consists of a treble thread, hard steel worm engaging with a phosphor bronze wheel, both entirely enclosed in an oil bath gear case, and fitted with ball thrust bearings. The spur gearing situated between the motor tank and the capstan head is formed entirely of steel with machine-cut teeth, and provides for two working speeds, the faster being intended for loads up to three-tenths of the full load. Change of gear is effected by mechanism operated from above the ground. The same mechanism also serves for disconnecting the motor entirely from the capstan barrel on occasions when it is desired to work the latter by hand spikes inserted in the usual pockets around the top of the barrel. The bevel gearing forming the final stage of the speed reduction is arranged within the capstan base, and comprises a steel pinion on the horizontal shaft gearing into a large steel crown wheel keyed to the barrel. A powerful brake, capable of sustaining the maximum load, is fitted on the motor shaft, and is constantly maintained "on," except while the motor is working, when it is automatically pulled "off" by a solenoid in the circuit.

The motors, which, together with the control gear, have been supplied by Laurence, Scott and Co., Limited, Norwich, are of the totally enclosed, compound wound, reversing type, designed to work at a slow speed, and capable of withstanding exceptionally heavy overloads for lengthy periods without damage. The control gear comprises a master controller worked by hand wheel above the ground level, and operating a relay main controller of the contactor type. Automatic overload and no-voltage release attachments are included and so arranged that if either breaks circuit while the motor is working, the capstan can only be started again by first bringing the controller back to the "off" position.

In capstan work the overload attachment is, of course, of

utmost importance, as the loads which may unwittingly or unavoidably be brought on to the hauling rope are quite indeterminate. This is particularly so in the case of the warping of vessels, as, while being hauled in, there is the possibility of the ship violently surging backwards due to some extraneous cause. When such a thing occurs, it is not only necessary that the motor should be protected from excessive current, but it is also most desirable that the capstan should not lose control of the ship, but should maintain the hauling rope taut. These conditions are met by the control gear, which has been fitted to these capstans. The main controller is so arranged that whenever the overload circuit breaker acts, the whole of the starting resistance is automatically thrown into circuit, and by the special windings adopted the motor is then able to maintain its full load torque, even when "stalled" or when being driven backwards by the overload. It will be understood that the arrangement acts equally well in either direction, the capstan being fully reversible. As soon as the overload ceases, the capstan operator brings the controller back to the starting position and commences winding in again. The whole of the electrical equipment is protected by a main cut-out switch, operated by a pedal projecting a few inches above the ground, so that in an emergency the entire circuit can be instantly disconnected. A watt-hour meter is fitted in circuit with each motor.

After erection the capstans were severely tested before acceptance. To prove their power the hauling rope was led from the capstan barrel around fairleads to a set of sheer legs, upon which loads of 20 tons and 15 tons were lifted at the specified speeds, and were also sustained and accurately lowered. The tests, which were repeated several times, were carried out with entire satisfaction.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE TWO-CYCLE MARINE DIESEL ENGINE.

SIR,—At the present time this is the subject of paramount interest to all marine engineers, as well as many others, and I venture to submit a few hurried observations on the matter, together with a criticism of certain features of weakness of the foreign types of engine.

All engineers, when taking up the subject, express apprehension at the high maximum pressure necessary for the Diesel cycle; there is a good deal of force in this objection, as it entails high maximum loads, and necessitates perfect workmanship in certain parts exposed to pressure, and forced lubricator for the bearings. However, there are two modifying factors which are commonly overlooked; the first is that the cylinders will be of very much smaller area that those to which the marine engineer is accustomed. For all moderate powers a bore of cylinder of from 20in. to 25in. will develop all the necessary power, and only in special cases will the bore go much beyond 30in., this size requiring a crank shaft of from 18in. to 19in. diameter. For several reasons where a large power is required it will be desirable to use a larger number of cylinders, but a large number of cylinders working on the single-action system by requiring a crank for each cylinder will greatly lengthen the engine and make for excessive cost. I think every engineer will agree that the eight, ten and twelve-crank machine is not a commercial proposition, being more or less of a freak machine, indicating that the problem has not been solved satisfactorily. Four cranks may be regarded as the desirable limit, and three cranks will be more than amply sufficient when the double-action system is resorted to, being then equivalent to a six-crank single-action machine.

The double-acting Diesel, as usually developed, suffers from at least two grave defects—(*a*) excessive complication beyond all justification; (*b*) the piston-rod is subjected to alternate tensile and compressive loads of from 60 tons in a small machine up to 200 tons in a big machine. It has been amply proved by experience that the piston-rods of internal combustion engines subject to alternate compression and tension are very liable to failure. The cause of this is undecided, but it is certainly not safe to work them with a stress of more than two tons per square inch. Consequently one square inch of piston-rod is required for every nine square inches of piston, or, in other words, the piston-rod must be one-third the diameter of the cylinder, and a 24in. piston will require an 8in. rod.

A piston-rod of these proportions is objectionable, as it passes through the centre of the combustion chamber; also, together with its packing, it will occupy a very large portion of the cylinder head, leaving very little space for the valves within the narrow annular ring of space between the rod packing and the cylinder wall, and within this ring numerous valves are crowded; moreover, the packing must be split to withdraw easily. For such very high loads it becomes essential to arrange that the piston-rod shall be worked always in tension; the rod will not then tend to buckle up, but to straighten under load, and with an equal factor of safety the rod may be one-sixth cylinder bore, and a 24in. piston will then have a 4in. rod; in practice it would be a 5in. rod, or thereabouts. The essence of the matter is that a load which is perfectly safe for a tie is dangerous for a strut of the same or larger dimensions.

The tandem construction has three further advantages in that the heat developed per revolution is divided between two cylinders and pistons which are free to expand, instead of being developed in one long cylinder, and the exhaust is taken away by two sets of ports instead of by a common exhaust port keeping pistons and liners much cooler and, therefore, more easily lubricated; also one cam shaft and reverse-control mechanism will serve in place of two cam shafts. The cooling arrangements for the piston-rod are perfectly accessible at all times, and the cooling medium gravitates downwards instead of having to be forced upwards.

A very valuable feature of the Diesel cycle is the absence of

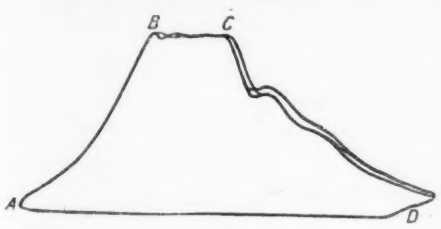


Fig. 1

shock on ignition of the fuel; in fact, the engine may be truly regarded as working with much the same stress as would be developed in an air compressor working to 500 lb. per square inch. Fig. 1, which is a cross diagram from a Diesel engine, illustrates this. The compression period from A to B occupies one half revolution, during which the pressure rises smoothly; fuel is sprayed in and burnt from B to C without increasing the pressure, and from C to D is expansion and exhaust. Fig. 2 shows a similar gas-engine card. On ignition at B the pressure goes up instantly to C—a sudden increase of 250 lb. per square inch. This important difference in the nature of the stress variation is of the greatest practical importance and entirely to the favour of the Diesel engine. Those who have indicated both kinds of engine are at once struck by the difference in the behaviour of the indicator pencil; in the one case a series of violent jerks, and in the other perfectly smooth motion.

It has frequently been stated that the injection of a double or treble charge of oil gives rise to excessive pressures; this is incorrect the only effect being a heavier impulse; so far from being danger-

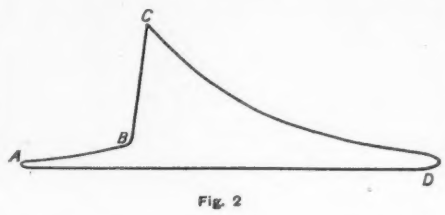


Fig. 2

ous it is a common practice when starting stationary Diesel engines to prime the injection valve with an extra charge of oil to secure an extra good start. The essential thing to be secured is correct injection of the fuel, neither early or late, and the ordinary arrangement of injection valve mechanism is not a good one for securing and maintaining this required accuracy of injection. The usual and unavoidable arrangement in the continental types of Diesel is to pivot the injection-valve lever on the same shaft which carries the scavenge-valve levers, this shaft being necessarily located about midway between the injection valve and the cam shaft; the arms of the injection lever will be of about equal length (as shown diagrammatically in Fig. 3), consequently the lift of valve and movement of cam roller will be equal. The amount of lift required is very small, about .05in., so that any cause which changes the relative position of cam to roller to the extent of say .02in. will give rise to serious inaccuracy, and owing to the smallness of the movement it is difficult to detect variation.

The proper method of mounting the lever is to pivot it as near the spraying valve as is practicable, and make the arms of the lever in a ratio of at least eight to one (shown diagrammatically in Fig. 4). The movement of the long armed lever is now multiplied to .4in. for a valve lift of .05in., and an inaccuracy of setting which was serious in the former case is now quite negligible; it must be remembered that the cam must be accurately set both for ahead and astern running, and for such a vital function as the correct injection of the fuel no care is too great, but it is difficult to see how the foreign designers can provide a separate fulcrum to carry the spraying lever, as the space is already over crowded with the numerous valves they deem to be necessary, there being generally six valves per cylinder head, *i.e.*, four air-scavenge valves, one air-starting and reversing valve, and the fuel-injection valve; a relief valve should be added, but this is not generally done. A four-cylinder engine thus has twenty-four valves, and the three-crank double-action engine about thirty-six valves, in addition to numerous inlet and outlet valves for the scavenging pumps.

The air-scavenge valves for a large engine will be fairly large and heavy; they have to be rapidly opened by cam action and closed by spring action within the period of time occupied by one-quarter revolution of the crank, or at twice the rate that a gas engine exhaust valve is operated; this necessarily throws considerable stress on the springs, which, on account of the small space available, have to work under severe stress. Too many springs or too heavily loaded springs constitute a grave defect for marine purposes.

Springs cannot be entirely avoided, but it is practicable to arrange that very few are necessary, and to work these with a low stress.

To provide a 2 to 1 volume of scavenging air to cylinder capacity will require, in round figures, some 4 cubic feet per indicated

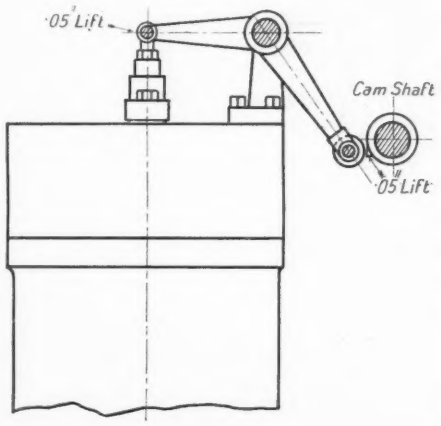


Fig. 3

horse-power per minute. This is an exceedingly large volume, but the pressure is very low, varying from 2 lb. per square inch to 7 lb. per square inch, according to speed of revolution and ratio of scavenge inlet area to cylinder volume, the slower the speed and the larger the area the smaller the pressure required.

A set of twin engines of 5000 indicated horse-power each will require blowing machinery capable of giving 40,000 cubic feet of air per minute, at an average pressure of 3 lb. per square inch, Leaving the question of engines aside for a moment, let us inquire how such a requirement would be met for other purposes; for blast furnaces, smelting, and numerous industrial processes requiring a large volume of air or gas compressed to one or two atmospheres the turbine compressor will beat any type of air pump on reliability, efficiency, weight and space, silence, and first cost. These virtues are of doubled importance for the particular application we have in view. Continuous reliability is a vital matter; economy of space and weight are next in importance, and efficiency and low cost are always desired. The rotary machine has three other advantages. It gives a continuous stream of air instead of a series of puffs; this is an advantage, as with one big pump supplying a number of cylinders the air is unequally distributed at certain speeds. The pumps, once they are installed, are of fixed volumetric capacity, whereas the turbine can be speeded up, not only to supply sufficient air to displace the burnt gases, but to ensure that the cylinder charge is clean and cool. As it is always necessary to provide considerable auxiliary power—either steam or electric—for use in port, this can be turned to account when at sea for driving the scavenging machinery, and to this extent increases the effective power of the main engines by some 10 per cent. to 15 per cent. by relieving them from the necessity of driving scavenge pumps, which consume quite a lot of power if the scavenging is effectively done.

Large high-speed air pumps running at 120-200 revolutions are bound to be inefficient, unreliable, noisy, and expensive. Some foreign makers already realise that the pump will suffer from these defects, and fit mechanically operated valves. This is a considerable improvement, but adds to the cost and number of big moving parts; moreover, it is difficult to apply to pumps which are lever-driven from the crosshead.

If a scavenging pump fails to deliver its air from any cause a curious series of interactions is set up in the motive cylinder which it normally scavenges. The spraying valve continues to spray in fuel; this burns correctly on the first stroke, but after the first stroke a mixture of vaporised oil and burnt gases not being scavenged out of the cylinder are re-compressed together with some air which is sucked in by the motion of the piston. When compression reaches ignition point a half-hearted pre-ignition will take place, there being usually insufficient oxygen present to support combustion.

The oil fuel pump of a Diesel engine is required to deliver a small quantity of oil against a pressure of 650 lb. to 800 lb. per square inch, and the oil needs careful filtration to prevent any sediment from being caught in the valves and allowing the oil to escape; duplicate pumps and piping should be so arranged that a defective pump can be switched off and an effective one started in

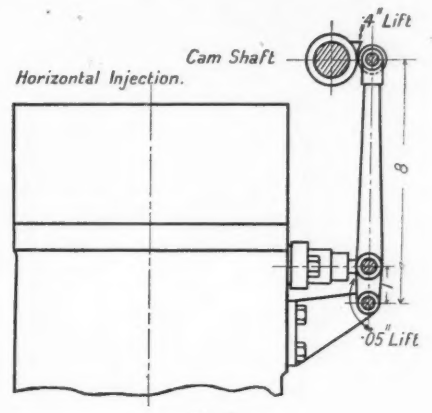


Fig. 4

while the defective one is adjusted. At reduced speeds only a small fraction of the full fuel charge is injected per stroke, and as the injection valve is open for a longer period a large excess of air-blast would enter the cylinder with the fuel, that is, unless it is provided against by the design, which should aim at securing a spray of uniform consistency under all conditions. Marine engine builders have yet to realise what a stupendous difference the Diesel engine will make to their methods of construction, for not only will the parts be very much smaller, but they will be standardised. Several unsuccessful attempts have been made to standardise the steam engine, but to no purpose, one great obstacle being the difference in the bores and capacities of cylinders. With the Diesel engine not only are the cylinders uniform in bore, but an increase of 1in. on the bore means a considerably increased power; also it is possible to set the maximum speed anywhere between 100 to 200 revolutions; consequently if a slightly larger power is required than that given by a standard size of engine, either the revolutions may be put up, or liners a fraction of an inch bigger fitted to the same jackets and frames.

The Diesel engine will likewise have an equally beneficial influence on the internal arrangements of ships at present with steam, on account of the great weight of machinery, and the necessity of having the coal handy to the boilers, it is essential to place the boilers and engines amidships if they are of much power; the greatly reduced weight per indicated horse-power of the single and double-acting Diesel, combined with the fact that the oil may be carried anywhere and piped to the engine-room, renders it perfectly practicable to place the largest power engines right astern, without throwing undue stress on the structure of the ship even when partly immersed, as would be the case in bad weather. This disposition of the machinery is of the greatest practical convenience both for passengers, as the best part of the boat will no longer be spoiled by the presence of machinery, noise and dirt, and for cargo, as one long hold with any number and disposition of hatchways will be practicable, in place of the fore-and-aft holds with four hatchways, as is now the usual arrangement. Moreover, the shaft will be from 100ft. to 150ft. shorter; this should go a great way to check torsional vibration, which has been proved to be the cause of many breakdowns in the past. Another thing to be noticed is that with the same weight of fuel, it will be possible to make a voyage of three times the length at present, and as it is an easy matter to carry oil fuel in odd spaces, and pipe it to the engine-room, a greater weight of oil-fuel could be carried in comparison with coal without inconvenience.

In conclusion, there is no need to dwell on the fact that the British marine-engine builders are sadly behind the continental ones, but the too hasty efforts on the part of those who are not sure of their ground is the worst way of mending matters.

FREDK. HUSSY TANNER.

December 18th.

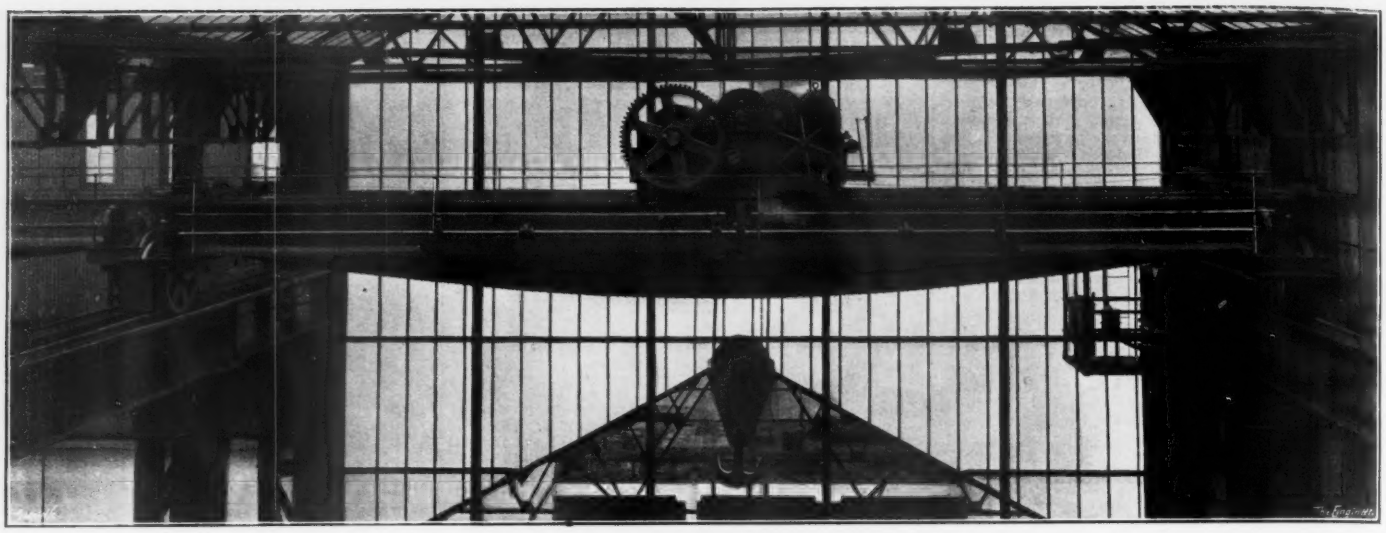
SIXTY-TON ELECTRIC OVERHEAD CRANES.

THE accompanying illustrations are of a three-motor, overhead, travelling, electric crane, constructed by Alex. Chaplin and Co., Limited, Govan, Glasgow, and is one of three of similar design built to the order of the London and Glasgow Shipbuilding and Engineering Company, Limited, Govan, and now installed in that company's turbine erecting shops, which were illustrated and described in THE ENGINEER for February 17th this year. One view is reproduced from a photograph of one of the cranes in position, and the drawing shows the details of this crane.

The working load of all the cranes is 60 tons, and they have been subjected to a test load of 72 tons. The span in the case of two of the cranes is 47ft., and of the third 42ft. 6in. The height to crane rails from floor of shop is 49ft. The speeds for the several operations of lifting, cross travel, and long travel are:—Lift, 60 tons at 5ft. per minute; 25 tons at 11ft. 6in. per minute, and lighter loads up to a speed of 15ft. per minute; cross travel, 60ft. to 90ft. per minute; long travel, 200ft. to 240ft. per minute. The hoisting motor is 33½ brake horse-power at 450 revolutions per minute; cross travel motor 10 brake horse-power at 475 revolutions per minute, and the long travel motor 27 brake horse-power at 450 revolutions per minute, all wound for an electromotive force of 500 volts and continuous current. The controllers are of the reversing tramway type, with regulating metallic resistances and hand levers. They are placed in the

SIXTY-TON ELECTRIC OVERHEAD CRANES

ALEXANDER CHAPLIN AND CO., LIMITED, GOVAN, ENGINEERS

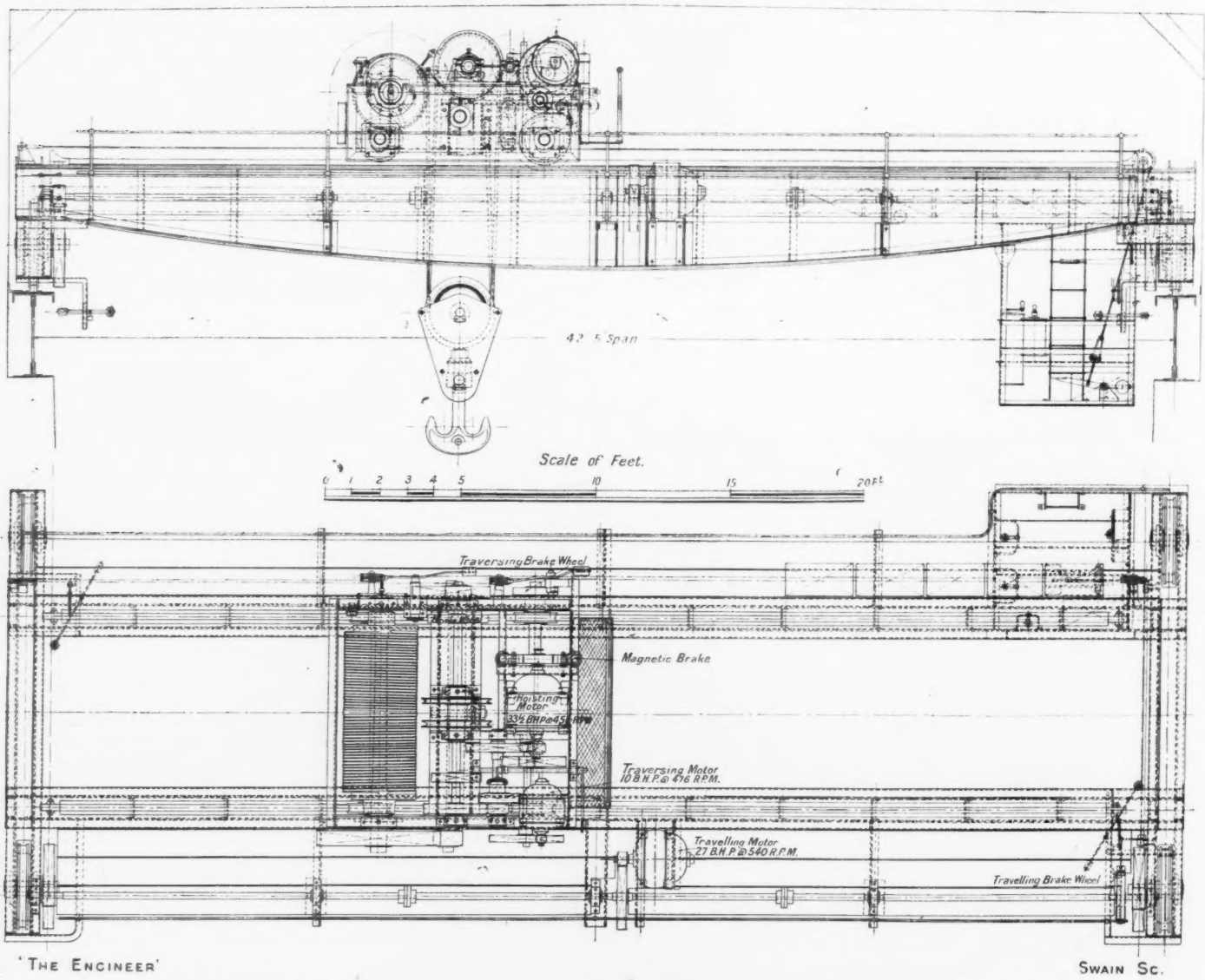


cage at one end and at one side of the bridge, so as not to interfere with the travel of the crab. A powerful automatic electric brake is fitted to the motor spindle, which is easily capable of sustaining the maximum load in event of current being interrupted from any cause, and a mechanical brake is fitted to the second motion shaft and is worked from the cage by a foot lever.

with mild steel shafts for the different motions. These shafts run in adjustable bearings, bushed with gun-metal. The whole is mounted upon four double-flanged mild steel rail wheels, 18in. diameter, turned on the tread and keyed on steel axles, running in cast iron bearings of self-oiling type, also bushed with gun-metal.

The hoist gearing is of steel, and is all machine cut from

mild steel plates and angles. They are 4ft. 1in. deep at the centre of the span. The end carriages are also built of mild steel plates and angles, and are also of box section. Each is fitted with two rail wheels, 3ft. diameter, having centres of cast iron, with doubled-flanged steel tires shrunk on. They are fitted with steel axles, running in cast iron bearings, spigoted and bolted to the webs of the carriages. The


42' 5" Span
Scale of Feet.
0 1 2 3 4 5 10 15 20Ft
Traversing Brake Wheel
Magnetic Brake
Hoisting Motor 93½ B.H.P.@ 45 R.P.M.
Traversing Motor 10 B.H.P.@ 416 R.P.M.
Travelling Motor 27 B.H.P.@ 540 R.P.M.
Travelling Brake Wheel
'THE ENGINEER'
SWAIN SC.

ELEVATION AND PLAN OF CRANE FOR GLASGOW SHIPBUILDING AND ENGINEERING COMPANY, LIMITED

The hoisting controller is provided on the lowering side with five brake contacts, so that at these positions the motor is short-circuited from the main and works as a generator through resistance, thus preventing the load from accelerating and causing damage to the armature. Messrs. Chaplin and Co., we understand, have used this system of rheostatic brake lowering with most satisfactory results since 1900.

The crab is built of mild steel plates and angles, and fitted the solid metal. The cross and longitudinal travel gear is also machine cut, and each of these motions is fitted with a brake, having a wood-lined strap, worked from levers in the cage. The lifts are taken by eight falls of special mild plough steel wire crane rope, and the lifting block is pivoted with a ram's-horn hook, with ball bearings under the head, so as to enable the maximum load to be easily rotated.

The bridge girders are of box section, and are built up of

wheels are keyed on the axles and turned on the tread. The cranes under notice were, we are informed, completed and tested in the works of the London and Glasgow Shipbuilding and Engineering Company within sixteen weeks of the receipt of the order for them.

FORTHCOMING ENGAGEMENTS.

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the Factory of Messrs. Otto Monsted, Limited, Margarine Manufacturers, at Southall. The party will leave Paddington Station by the 2.23 p.m. train, arriving at Southall at 2.56 p.m.

SATURDAY, DECEMBER 30TH.

THE INSTITUTE OF MARINE ENGINEERS.—58, Romford-road, Stratford, E. Social Evening for the Junior Section. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. "Boiler Shop Design," Mr. W. J. Bennett. 6.45 p.m.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture II., "The Duration of Youth," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

TUESDAY, JANUARY 2ND.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture III., "Colours and Patterns of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

ROENTGEN SOCIETY.—Institution of Electrical Engineers, Victoria Embankment. "The Clinical Significance of X-ray and Radium Measurements," Mr. S. Russ. "The Right and Wrong Side of the Picture: Has a Mistake been Made?" Dr. W. Cotton. 8.15 p.m.

THURSDAY, JANUARY 4TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture IV., "Young Animals at Home," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

FRIDAY, JANUARY 5TH.

JUNIOR INSTITUTION OF ENGINEERS.—The Institution of Electrical Engineers, Victoria Embankment, W.C. The Presidential Address on "Engineering Considerations in Wireless Telegraphy," Commendatore G. Marconi, has been postponed.

GEOLOGISTS' ASSOCIATION OF LONDON.—University College, Gower-street, W.C. The following papers will be read:—"On the High Terrace Gravel and on a Palæolithic Implement Factory, Dartford Heath," Mr. R. H. Chandler and Mr. A. L. Leach. "On the London Clay and Bagshot Beds (Passage Beds), and on the Gravel of Shooter's Hill, Kent," Mr. A. L. Leach. The lectures will be illustrated with lantern views. 8 p.m. The Council will meet at 7 p.m., and the Illustrations Committee at 6.15 p.m.

SATURDAY, JANUARY 6TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture V., "The Feeding of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

TUESDAY, JANUARY 9TH.

ROYAL INSTITUTION.—Albemarle-street, Piccadilly, W. A Christmas Course of Illustrated Lectures adapted to a Juvenile Auditory on "The Childhood of Animals." Lecture VI., "The Play of Young Animals," Mr. P. Chalmers Mitchell, F.R.S. 3 p.m.

WEDNESDAY, JANUARY 10TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. "Repairs to Steam and Petrol Vehicles," Mr. D. J. Smith. 8 p.m.

THURSDAY, JANUARY 11TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS: GRADUATES SECTION.—13, Queen Anne's-gate, Westminster. "Balancing," Mr. A. E. Pettit. 8 p.m.

ASSOCIATION OF MINING ELECTRICAL ENGINEERS: LONDON BRANCH.—Junior Institution of Engineers, 39, Victoria-street, S.W. Discussion on the paper, "Electricity in connection with Explosives." 8 p.m.

FRIDAY, JANUARY 12TH.

BATTERSEA POLYTECHNIC.—Battersea Park-road, S.W. "The Measurement of Light," Dr. J. S. Dow. 7.30 p.m.

THURSDAY, JANUARY 18TH.

IPSWICH ENGINEERING SOCIETY.—At the Museum, High-street, Ipswich. "Petroleum and other Mineral Oils: Their History, Production, and Uses," Mr. A. E. Kidner. 8 p.m.

FRIDAY, JANUARY 19TH, 1912.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—St. Andrew's Halls, Glasgow. The "James Watt" Anniversary Dinner.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

Manufactured Iron and January Quarter Day.

THE bar trade closes the year in an exceptionally good position. Many makers of unmarked bars have sold their output for the next two months, and have had difficulty in meeting the specifications that have recently been given out. Merchant qualities can still be bought at £6 17s. 6d. delivered, but some producers will not accept less than £7. Common iron for nut and bolt making commands £6 12s. 6d. An immediate advance of 10s. per ton is looked for in marked bar prices, which will raise the basis to £8 10s., with £9 2s. 6d. as the price of the Earl of Dudley's Round Oak iron, but whether the formal declaration of the advance will be deferred until the January quarterly meeting appears, as this is written, uncertain. The meeting itself is fixed for January 11th, and is being looked forward to with great interest, since the opening meeting of the year is always regarded as a very important fixture, and upon this occasion is, happily, certain to show a great improvement in trade compared with any similar meeting for fully three years past. It would scarcely be incorrect to make an even more distant comparison. Gas strip at £6 15s. and £6 17s. 6d. is in brisk request. Contracts placed prior to the last advance are being rapidly worked off. Iron hoops have just been advanced 10s., to £7 10s., with the usual 5s. extra for cut lengths, making these last £7 15s. per ton.

Galvanised Sheets and Spelter.

Other branches of the finished iron trade are steady. Sheets show little buoyancy, though competition is so far modified as to admit of producers making more stringent terms as regards specifications, contract obligations being now more generally insisted upon. Galvanised corrugated sheets of 24 gauge command £11 5s. to £11 10s. f.o.b. Liverpool. Prices of spelter continue very stiff, and consumers are standing off the market as much as possible. Ordinary qualities of virgin metal are quoted at £26 15s. to £26 17s. 6d., and special qualities are £27 5s. to £27 10s. Black sheets for merchant purposes and for use by the galvanisers are rather firmer, but prices do not show any increase at present commensurate with the dear price of pig iron. Singles are quoted £7 12s. 6d. to £7 15s., doubles £7 15s. to £7 17s. 6d., and trebles £8 5s. to £8 7s. 6d. per ton in this district.

Boiler-plate and Engineering Iron Prices.

For Lancashire steam boiler manufacture and for the manufacture of underframes for railway goods wagons, there is a considerable demand in the Midlands for best Yorkshire iron, and it is also being used to some extent for special cable and rivet manufacture. The basis price for Farnley iron of this description is, for bars, £20 per ton, in weights not exceeding 3½ cwt.; while above 3½ cwt. and not exceeding 5½ cwt. the price is £21, and above 5½ cwt. £22 per ton. Angle and tee iron up to 10 united inches is £22 as the basis, and rivet iron £27 basis. Boiler plates up to 3½ cwt. are £25, 3½ cwt. to 5 cwt. £27, and above 5 cwt. £29 per ton. Hammered blooms for forgings are quoted £19 basis.

Pig Iron Trade.

The output of pig iron is so steadily absorbed that stocks are light throughout the district, and values are very firm at last week's level. The support forthcoming from the Middlesbrough market has the effect of confirming smelters in their policy of caution with regard to forward business. South Staffordshire forge qualities are quoted 50s.; part-mine, 53s.; best all-mine, 80s.; and cold blast, 115s. per ton. The market has narrowed considerably as regards Northamptonshire iron, and producers are taking advantage of the squeeze to hold out for 51s. to 52s. Derbyshire brands realise 52s. 6d. to 53s. 6d. Demand alike for Staffordshire and Midland qualities continues excellent, and expectations concerning next year are as good as need be with sellers generally. Foundry iron is in particularly good sale and values are improving, local consumers being busier than for a long while past, and therefore demanding more prompt deliveries and greater attention from the furnace owners generally.

Raw and Manufactured Steel.

The steel trade is very active, producers of all classes of material being busy. Billets and sheet bars are in small supply, and consumers complain of the difficulty of securing adequate and early supplies. Quotations are named which are simply surprising, and it will be most unusual if they are realised. Early deliveries being scarce, Bessemer sheet bars of native make are quoted as high as £5 5s. to £5 7s. 6d. per ton, and Siemens £5 7s. 6d. to £5 10s. Local consumers are at a disadvantage in that local output is in very limited hands. In consequence of the recent rise in steel billets producers of fine steel strip have notified a rise of 5s. in price, making the basis £7 12s. 6d. For finished steel values are hardening, steel hoops being now £7 12s. 6d., or a rise of 7s. 6d. on the week. There is an extraordinary demand for cold rolled sheets which is forcing up the selling rate. Best thin stamping sheets and black plates also meet with additional forward delivery. Cold rolled sheets are quoted £10 10s. per ton, and black plates £11 10s.

Railway Rolling Stock.

Railway rolling stock manufacturers are fairly well employed, the chief orders in hand being for wagons for home railway companies. There are some fair inquiries on the market at present. Among some small contracts recently placed in this district are orders for 40 bogie carriage underframes, &c., for the broad gauge section of the Bombay, Baroda, and Central India Railway. One of the local companies is completing a contract for the supply of thirty new all-steel passenger cars for the District Railway Company, London. Rolling stock business on export account has been smaller this year than last.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

The Promise of a Boom.

TRADE in pig iron has gone through many vicissitudes since the commencement of the year. For the first two or three months business showed every appearance of continued good trade throughout the year; then there was a gradual falling off for a long period, the feeling being one of extreme dulness, and prices showing little fluctuation. During the last two or three months there has been a welcome revival, and the year closes with every prospect of improvement during the coming twelve months. The attendance on the Iron Exchange on Wednesday was meagre in the extreme, and business is suffering from the effects of the holidays in all departments.

Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 56s. 6d.; Staffordshire, 57s. 6d.; Derbyshire, 57s. 6d.; Northamptonshire, 57s. 4d.; Middlesbrough, open brands, 59s. 4d.; January-March, 60s. Scotch: Gartsherrie, 65s.; Glengarnock, 63s.; Eglinton, 62s. 6d., delivered Manchester; West Coast hematite, 67s. to 67s. 6d.; East Coast ditto, 65s. 6d. to 66s., both f.o.t. Delivered Heysham: Gartsherrie, 63s.; Glengarnock, 61s.; Eglinton, 60s. 6d. Delivered Preston: Gartsherrie, 64s.; Glengarnock, 62s.; Eglinton, 61s. 6d. Finished iron: Bars, £7 5s.; hoops, £7 12s. 6d.; sheets, £8 15s. Steel: Bars, £7 to £7 10s.; Lancashire hoops, £7 12s. 6d.; Staffordshire ditto, £7 17s. 6d.; sheets, £8 5s. to £8 10s.; boiler plates, £8 to £8 5s.; plates for tank, girder, and bridge work, £7 5s. to £7 10s.; English billets, £5 5s. to £5 10s.; foreign ditto, £4 18s. to £5; cold drawn steel, £9 5s. to £9 10s. Copper: Sheets, £79; tough ingots, £67 10s. to £68; best selected, £68 10s. to £69 per ton; copper tubes, 9⅜d.; brass tubes, 8d.; condenser, 9d.; brazed brass tubes, 9½d.; rolled brass, 7¼d.; brass wire, 7¼d.; brass turning rods, 7½d.; yellow metal, 6¾d. to 6⅞d. per lb. Sheet lead, £19 10s. to £19 15s. per ton. English tin ingots, £205 per ton. Aluminium, £60 to £62 per ton.

The Lancashire Coal Trade.

There was also a very poor attendance on the Coal Exchange, and very little business was done.

Labour Dispute in the Cotton Trade.

Lancashire has for some months enjoyed a spell of really good trade, and it is to be hoped that the weavers will think at least twice before they throw the whole of the staple industry into a state of chaos by their unreasonable attitude in the present dispute. The membership roll of the Weavers' Union has for some time been making great strides, and it is said that non-unionists form only a tiny fraction of the great body of weavers. Not satisfied with this progress the workers are in effect demanding that the manufacturers shall employ no persons who do not belong to this union. They go even further in insisting that the employers shall discharge the few workers who still prefer to remain outside this organisation. This the masters naturally decline to do on principle. Notices have been posted at the mills in North and North-East Lancashire proclaiming a general lock-out in the weaving section of the industry, which will affect 160,000 operatives. At Colne and Nelson, where the dispute originated, 20,000 looms will be rendered idle, and 30,000 operatives thrown out of work. At Preston 14,000 weavers will be thrown out of employment, and at Burnley 40,000 persons will be stopped. In Blackburn there are 137 weaving sheds containing 81,300 looms. The dislocation of trade will not stop with the weaving industry, for the spinners, who make yarn for looms, will be unable to dispose of the whole of their production if there are no looms at work, and the master spinners have decided to close the mills of the firms belonging to the Association on three days per week commencing on Saturday next, unless the dispute is settled in the meantime. At present both masters and men are standing firm.

BARROW-IN-FURNESS, Thursday.

Hematites.

The condition of the hematite pig iron trade of this district is one of much steadiness. There is not much business being done this week on account of the holidays, but the demand of late has been quickened, and there is every prospect of much busier times in the hematite pig iron trade. Such an improvement is very welcome, but as to whether it will only be of short duration cannot for the present be said. Still a much heavier delivery of iron is required by steel makers, especially those who turn out shipbuilding material, for recent placings of Admiralty work have made the demand for plates and castings fuller. Local steel makers' wants remain about the same. Unfortunately, shipbuilding material is not being made at Barrow just now. Prices are unchanged this week, with makers quoting 67s. per ton net f.o.b. for mixed numbers of Bessemer iron. Special sorts of iron are in steady demand at 70s. to 72s. per ton. There is no activity in warrants this week. Sellers are quoting 64s. 4d. per ton net cash.

Iron Ore.

For iron ore there is a good, steady demand on local account, and satisfactory business is being carried on with outside smelters. Prices have recently materially hardened, especially for the best classes, and Hodbarrow sorts are at 22s. 6d. per ton, with poorer qualities at 15s. per ton net at mines. Spanish ores are at 21s. 6d. per ton delivered to West Coast works. Last week 5600 tons were imported into Barrow. Irish ores are only imported at intervals.

Steel.

The demand for all classes of steel keeps active, and there is a considerable improvement to note in the request for steel shipbuilding material. New orders for warships have been given out at Barrow and on the Clyde. The plates, castings, &c., for Messrs. Vickers are obtained from their own works at Sheffield, from Scotland, and South Wales, no trade being done locally. For rails there is a steady request in heavy sections at £5 12s. 6d. to £5 15s. per ton. Light rails are at £6 5s. to £7 per ton, and represent an easy business. The demand for tin bars is quiet, and hoops enjoy a fair trade.

Shipbuilding and Engineering.

The orders for the new British battleships have been given to Vickers, and to Beardmore, of Glasgow, concerns which are allied to a great extent. Their tenders were the lowest.

Fuel.

The demand for coal is steady, with good steam sorts at 12s. 6d. to 16s., East Coast coke at 20s. to 22s. 6d., and South Wales coke at 21s. per ton delivered at West Coast works.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

Trade in 1911.

A GENERAL review of the iron and steel trades of this district shows that employment has been much better, taking the year as a whole, than in 1910. The second half of the year was the more satisfactory period so far as the volume of work was concerned. Thus the demand for railway material, axles, tires, springs, &c., over the greater part of the year was not vigorous, but since mid-summer most mills and shops have been well employed. These remarks hold good for other engineering requisites—small forgings, castings and the like. The demand from the shipbuilding centres was well maintained all through the year. Following the requirements of the railways and engineers, the demand for crucible steel has kept fairly good throughout the year, and home and foreign orders have kept the makers of the best qualities well employed all the year. The consumption of Swedish bar iron used for making crucible steel was larger than during last year, and prices have steadily advanced, until at the present time they stand at 30s. above the quotations eighteen months ago. As regards the position of the armament branches, full employment has been the rule all through the year. The various armour-plate plants of the country have been continuously busy. Home Government requirements have included armour for the battleships King George V., Centurion, Audacious and Ajax, and the battleship-cruisers Queen Mary, Australia, and New Zealand—in all about 20,000 tons, distributed amongst the five makers. In addition there have been orders on account of ships building for Spain, Brazil, Chili, and Turkey. Armour-plate makers state that the work and the time spent on present armour is out of all proportion to the weight, and the need for new plant to manufacture it continues. The mere tonnage therefore gives little indication of the work involved, compared with what was the case only a few years ago. Heavy gun and marine forgings have also been in good request. There has also been a good demand for shells and projectiles, chiefly to replace ordinary wear and tear or as necessitated by the new developments in ordnance. The year closes with makers of armament material waiting for the new orders of the 1911 programme. The pig iron market here has been in a state of suspended animation for the greater part of the year. West Coast hematite started at 77s. and ends at 77s., with only one break about the end of June, when prices reached their minimum of 75s. East Coast hematite has shown a little more movement, starting the year at 70s., rising in May to 72s., and falling back to 67s. 6d.; from then there has been a rapid recovery to about the opening prices. Lincolnshire No. 3 iron commenced at 48s. 6d. at the furnaces, fell to 47s. in May, and has since recovered to 48s. Derbyshire iron has followed suit.

A Holiday Week.

Owing to the Christmas holidays most of the local works have been closed for the week, but several reopened on Wednesday. There has been little business to record in the pig iron markets, but prices are nominally firmer, with premiums of 1s. to 2s. quoted on Lincolnshire non-official basis prices. Current quotations:—Lincolnshire, No. 3 foundry, 52s.; ditto, forge, 51s.; ditto, basic, 53s. 6d.; Derbyshire, No. 3, 52s. to 53s.; ditto, forge, 50s. to 51s.; all per ton delivered Sheffield or Rotherham. Hematite: West Coast, 77s. to 78s., less 2½ per cent. discount; East Coast, 73s. to 74s. net. Bar iron, £7 5s.; hoops, £7 5s.; basic billets, £5 7s. 6d. to £6; Siemens high-carbon billets, £7 5s. to £7 10s.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Pig Iron.

THE revival in the pig iron trade is maintained, and a brisk business is being done this week, notwithstanding that many are still on their holidays. The speculators in Cleveland warrants

are operating largely, and this has rather upset the calculations of legitimate traders. London houses, which are said to be the chief holders of Cleveland warrants, have, during the last fortnight, been operating freely, as have also Glasgow firms, and there have undoubtedly been more lively doings in the warrant market during the last fortnight than at any time this year. Producers have raised their prices of No. 3 Cleveland G.M.B. pig iron for January delivery to 51s. per ton, and for delivery over the first quarter of 1912 to 52s. 6d., the latter the best price for over two years. No. 1 for prompt delivery is up to 54s. 6d., No. 4 foundry to 50s. 6d., No. 4 forge to 50s. 3d., and mottled and white to 50s., with 1s. 6d. per ton more for delivery up to the end of March. The average net price realised by the ironmasters this year to end September for No. 3 was only 48s. 8½d., against 50s. 6d. in the whole year 1910, and it was the worst average price reported in any of the last six years. The reductions in blast furnacemen's and ironstone miners' wages during 1911 indicate declining realised prices for Cleveland pig iron.

Hematite Pig Iron.

Prices of East Coast hematite pig iron continue to rise steadily, and the year 1911 is closing with the quotation for mixed numbers at the highest figure that has ever been touched during the twelve months. In the early part of the year 65s. 6d. was reached, and there then commenced a fairly continuous fall to 60s. 6d. per ton in November, since when the demand has become decidedly brisker, and the quotation has become strong at 66s. per ton for January delivery, and 67s. 6d. for delivery over the first quarter of 1912. There has been a large business done in December, and the advances have been brought about entirely by legitimate trading, for speculators cannot well operate in this description of pig iron, seeing that there are no East Coast hematite warrants. Rubio ore continues nominally at 21s. 6d. per ton delivered at Middlesbrough, consumers still holding off, notwithstanding that they have booked large contracts. Furnace coke is extremely firm at 17s. per ton for next half-year's delivery, and it cannot so readily be bought as the production has been curtailed, because it is more profitable to the colliery people to sell the coal rather than convert it into coke.

Shipments of Pig Iron, &c.

The exports of pig iron from the Cleveland district in December have been remarkable, by far the best reported in any December on record, and the best of any month this year.

Manufactured Iron and Steel.

The position of manufacturers of finished iron and steel has greatly improved of late, and they are able to keep their works going very fully. The advances in prices, which have lately been made in plates, angles, and sheets are firmly maintained. Steel ship plates are at £7, and steel ship angles at £6 12s. 6d., both less 2½ per cent., and delivered at any North-East Coast shipyard, with a rebate of 5s. per ton where consumers buy materials exclusively from members of the plate and angle makers' combination. Iron ship plates are at £6 12s. 6d., and iron ship angles at £7, both less 2½ per cent. f.o.t. Steel sheets—plain—are up to £7 10s., less 2½ per cent. f.o.t., and galvanised and corrugated steel sheets are at £11 10s. per ton for 24 gauge, less 4 per cent. f.o.b. The demand for the last named is particularly good on export account, and especially for India and Japan. Common iron bars are at £7, less 2½ per cent. f o.t., and steel bars can be bought at £6 5s., less 2½ per cent. Steel hoops are firm at £6 12s. 6d., steel strip at £6 10s., and steel joists at £6 7s. 6d. to £6 12s. 6d., all less 2½ per cent. f.o.t. Heavy steel rails are steady at £5 12s. 6d. net f.o.b., cast iron chairs at £3 12s. 6d. net f.o.b., and steel sleepers at £6 7s. 6d. net f.o.b.

Coal and Coke.

The position continues exceedingly good for those engaged in the coal trade, buying having been very brisk. The outlook for next year is very promising if labour difficulties can be avoided, of which there is some doubt. Best Durham gas coals are realising from 12s. 6d. to 12s. 9d. per ton f.o.b., and seconds are up to 12s. Bunker coals have risen quite 3s. 6d. per ton since the summer, for best are now quoted at 13s. per ton f.o.b. Tyne dock, and 12s. to 12s. 6d. per ton has to be paid for ordinary.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

The Warrant Market.

ABOUT 130,000 tons of pig iron warrants changed hands in the course of last week, this being the largest business done in any one week during the year. Prices of Cleveland warrants reached 50s. 6½d. cash, being rather over the price with which the year began, and nearly 5s. per ton above the lowest price of the year, which was 45s. 7½d. in May. A considerable amount of realising for profit brought back prices to some extent, and yet there remained a gain of 7½d. on the week. Merchants state that makers are very firm sellers, and the reduction in stocks and increased shipments go to support their attitude in this respect. Since last report business has been done in Cleveland warrants from 50s. 6½d. to 50s. 2½d., and up again to 50s. 8½d cash, 50s. 10d. to 50s. 6d. one month, and 51s. 4d. to 51s. 2½d. and 51s. 6d. three months. Transactions have also been noted at 50s. 7d. for delivery in twenty-one and twenty-five days, 50s. 11d. for 13th February, and 51s. 6d. for 15th March.

Advance in Scotch Pig Iron.

While there has been comparatively little done in Scotch pig, as far as fresh business is concerned, there has been a further general advance in prices, in sympathy with the state of the warrant market. Govan and Monkland, Nos. 1, are quoted f.a.s. at Glasgow, 58s. 6d.; Nos. 3, 57s. 5d.; Carnbroe, No. 1, 63s.; No. 3, 59s. 6d.; Clyde and Calder, Nos. 1, 64s.; Nos. 3, 59s.; Gartsherrie, No. 1, 64s. 6d.; No. 3, 59s. 6d.; Summerlee, No. 1, 64s. 6d.; No. 3, 60s. 6d.; Langloan, No. 1, 65s.; No. 3, 60s.; Coltness, No. 1, 82s. 6d.; No. 3, 60s.; Eglinton, at Ardrossan or Troon, No. 1, 58s.; No. 3, 57s.; Glengarnock, at Ardrossan, No. 1, 65s. 6d.; No. 3, 60s. 6d.; Dalmellington, at Ayr, No. 1, 59s. 6d.; No. 3, 57s. 6d.; Shotts, at Leith, No. 1, 65s.; No. 3, 60s.; Carron, at Grangemouth, No. 1, 65s. 6d.; No. 3, 60s. 6d. per ton. There are 84 furnaces in blast in Scotland, compared with 85 at this time last year. Scotch pig iron shipments in the past week 3921 foreign and 1573 coastwise, the total of 5494 tons comparing with 4167 in the corresponding week of last year.

The Hematite Trade.

There has been a considerable amount of business in Cumberland hematite warrants since last report, transactions taking place at 64s. 4d. for delivery in one month, 64s. 3d. six weeks, and 66s. three months. Inquiry for Scotch hematite pig iron has been quiet owing to the holidays, and the price is 68s. to 68s. 6d. per ton for West of Scotland delivery.

Finished Iron and Steel.

The iron and steel works have been running this week to their full capacity in order to complete contracts that are due by the end of the year. The New Year holidays will be observed next week, when the works will be closed, resuming on the 8th January. The outlook in the steel trade for the coming year is encouraging. Orders secured will be sufficient to keep the works employed for several months. Not only is there a remarkable absence of foreign competition, but shipbuilding material has lately been in demand for export to the Continent. The year finishes with prices of steel as follows:—Angles, £6 15s.; ship plates, £7 2s. 6d.; bars, £7 15s.; and boiler plates, £7 17s. 6d., all subject to 5 per cent. discount for delivery in the Clyde district. In the malleable ironworks there is a large amount of business still to be overtaken. Unfortunately the prices are not satisfactory. Makers are looking forward to an improvement in this respect in the coming year. The basis price now quoted is £6 2s. 6d. to £6 5s. for crown bars, subject to the usual discount.

The Coal Trade.

The coal market has been quiet owing to the holidays, but the week has been a busy one at the pits, and in the operations attending delivery and shipments. The pits will be closed during next week for the New Year holidays. The closing prices for the year of coal f.o.b. at Glasgow are:—Steam coal, 10s. 3d. to 11s. 3d.; ell, 11s. to 12s.; splint, 12s. to 12s. 6d.; washed treble nuts, 10s. 9d. to 11s.; doubles, 9s 9d. to 10s.; and singles, 9s. 3d. to 9s. 6d. per ton. House coal for home use has met with a ready sale this week at firm prices in consequence of colder weather.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade, Cardiff.

THE week was again most disappointing, and the accumulation of stocks day after day still further increases difficulties. Most of the leading coalowners had full order books, and, with improved weather, the prospects were that a good deal of business might be done. In one respect there was a considerable quantity of coal to be shipped on Italian account, and old members on 'Change said that no falling off in price was likely until about the middle of January.

Present State of Trade.

When this week opened it was stated that a good deal of firmness characterised trade. Sellers were not disposed to relax quotations, and the tendency of large and small coal was to harden. Prior to Christmas 17s. 6d. was named as a prominent quotation for best steam, though 17s. was more to buyers' liking, especially as there were questions in abeyance which may yet end in a strike. On 'Change it was announced that efforts are being made to replace English and Welsh coal by Russian for dredging purposes in the Baltic, to the extent of about 16,000 tons annually. On Christmas Day there was no business done in the steam or other branch of the coal trade. Mid-week there was a slight movement, but buyers and sellers were content for lack of fresh material to rely on the latest obtainable quotations, which were as follows:—Best large steam, 17s. to 17s. 6d.; best seconds, 16s. 3d. to 16s. 9d.; ordinaries, 15s. 6d. to 16s.; best drys, 16s. 3d. to 17s. 6d.; ordinary drys, 15s. 3d. to 15s. 9d.; best washed nuts, 14s. to 15s.; seconds, 13s. 6d. to 14s. 6d.; best washed peas, 12s. 6d. to 13s. 6d.; seconds, 11s. to 12s.; best bunker smalls, 8s. 9d. to 9s. 3d.; best ordinaries, 8s. 3d. to 8s. 6d; cargo smalls, 6s. 6d. to 7s. 3d.; inferior smalls, 6s. to 6s. 6d.; Paris nuts, 22s. 6d. to 25s. net; French nuts, same; German nuts, 22s. to 24s. net; beans, 19s. 6d. to 22s. 6d.; machine-made large peas, 11s. 9d. to 13s. 3d. net; Rubbly culm, 5s. to 5s. 6d., less 2½; duff, 3s. to 3s. 3d.; best steam coal, 17s. to 18s. 3d.; seconds, 13s. 9d. to 14s. 3d.; small, 14s. 6d. to 15s. 3d., all less 2½. Patent fuel, 14s. 6d. to 15s. 3d., less 2½. Washed smalls, 8s. 6d. to 9s.; black vein, Monmouthshire, 16s. to 16s. 3d.; ordinary Western Valley, 15s. 3d. to 15s. 9d.; best Eastern Valley, 14s. 6d. to 15s.; seconds, 13s. 6d. to 14s. Bituminous: Best households, 17s. to 18s.; best ordinaries, 15s. 6d. to 16s. 6d.; No. 3 Rhondda, 17s. to 17s. 6d.; brush, 13s. 3d. to 13s. 9d.; smalls, 9s. 9d. to 10s.; No. 2 Rhondda, 13s. to 13s. 3d.; through, 9s. 9d. to 10s. 3d.; smalls, 6s. 3d. to 6s. 9d. Patent fuel, 15s. to 17s. Coke: Special foundry, 24s. to 25s.; foundry, 17s. 6d. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 29s. to 29s. 6d.

Newport (Mon.) Coal.

Some degree of slackness was noticeable about the close of the week, for which Christmas holidays were accountable. In most cases sellers maintained a firm tone, and quotations were well kept. Market this week has been under holiday conditions; but the tone is good and prospects satisfactory. Latest reliable prices:—Best Newport black vein, 15s. 9d. to 16s.; Western Valleys, 15s. to 15s. 6d.; Eastern, 14s. 3d. to 14s. 9d.; other kinds, 13s. 3d. to 13s. 9d.; best smalls, 7s. 9d. to 8s.; seconds, 7s. to 7s. 6d.; inferiors, 6s. to 6s. 9d. Bituminous: Best households, 16s. to 17s.; seconds, 15s. to 15s. 6d. Patent fuel, 16s. to 16s. 6d. Coke: Foundry, 17s. to 20s.; furnace, 15s. 6d. to 16s. 6d. Pitwood, 28s. to 29s.

Swansea Coal.

The tone of trade was again decidedly satisfactory, and the only drawback was the weather, which continued bad. Following Christmas there was little business done. Approximate closing quotations:—Best malting, large, 21s. to 23s. net; second, 19s. 9d. to 20s. 9d.; big vein, 19s. 6d. to 20s., less 2½; red vein, 13s. 9d. to 14s. 9d.; machine-made cobbles, 19s. 6d. to 21s. 6d., less 2½.

Swansea Valley.

In the week preceding Christmas the trade of the district was better and of greater quantity than for any similar period in the history of the valley. Up to mid-day on Saturday there was marked animation in all departments, and returns are expected in several cases to prove a record, especially in the output of copper, spelter, steel, and tin-plates.

Iron and Steel.

The week before Christmas was a very busy one at Dowlais. All the furnaces and mills were in full work and the tonnage of steel produced was a considerable one. The blast furnaces which are connected with the Bessemer plant were very busy, and the Goat Mill and rail banks were kept going from morning until night. Tin bar, steel rails, blooms, and a small percentage of sleepers formed the make, which kept the men busy, and was gratifying to the management. Only approximate quotations are given this week:—Rails, heavy sections, £5 12s. 6d. to £5 15s.; light, £6 5s. to £7 10s. Bessemer tin-plate bars, £5 to £5 2s. 6d.; iron ore, Newport, 20s. 6d. to 21s.; second quality, 19s. 6d. to 20s.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(From our own Correspondent.)

Rheinland-Westphalia.

ACTIVITY continues satisfactory, and the tone of the market is firm. At a meeting of the steel makers on the 19th inst., the condition of the steel trade was reported to be favourable, orders for the first quarter of 1912 coming in freely, and the majority of consumers having already placed their requirements for that period. Manufacturers of semi-finished steel continue well occupied, and they have been able to realise higher prices in a few instances. An active business is being done on foreign account at rising quotations. The State Railways have now placed their requirements for rails and sleepers to be delivered in the first six months of the new year. The requirements of the Baden Railways for the first two quarters of 1912 are about equal to those of the year before. Heavy railway material continues in very good call on foreign account, and several large orders have been secured. Light section rails are moderately well inquired for. The next meeting of the steel makers is to take place on the 18th of January.

The Silesian Iron Industry.

Reports regarding the iron and steel business remain satisfactory, all the principal trades being well occupied. Contracts are coming in more freely, and the outlook may be considered favourable.

List Quotations.

The following are the latest list rates per ton, free at works:—Raw spathose iron ore, M. 11.60; roasted ditto, M. 16.50; Nassau red iron ore, 50 per cent. contents, M. 14.50; white forge pig, M. 72; Siegerland brands, M. 62; Rhenish-Westphalian brands, M. 62; iron for steel making, Siegerland quality, M. 64; Rhenish-Westphalian quality, M. 66; German Bessemer, M. 74.50; basic, free Luxemburg, M. 51 to M. 52; Luxemburg forge pig, free Luxemburg, M. 48; Luxemburg foundry pig No. 3, M. 52.50 to M. 53.50; German foundry pig No. 1, M. 70.50; No. 3, M. 67.50; German hematite, M. 74.50; good merchant bars, M. 132 to M. 135; common basic sorts, M. 106 to M. 110; basic hoops, M. 127.50 to M. 132.50; common basic plates, M. 127 to M. 129; steel plates for boiler making purposes, M. 137 to M. 139; sheets, M. 140 to M. 145; drawn steel wire, M. 122.50.

The German Coal Market.

A steady and improving trade is being done on the Rhenish-Westphalian coal market in engine fuel, while comparatively little life is stirring in house coal, owing to the exceptionally mild weather. From the Silesian coal industry much the same is reported, inquiry and demand for all descriptions of engine coal being lively and rates firm.

Austria-Hungary.

During this week and the last only a moderate business has been put through, consumers being disinclined to purchase largely, and next to no speculative sales are taking place. Rates have shown comparative stiffness, but they are generally complained of as being unremunerative. The Austro-Hungarian coal trade does not present any feature of interest, slackness in demand being reported from most districts.

Good Trade in Belgium.

Fair accounts are given as regards demand and consumption in the Belgian iron industry. Makers have been fortunate in securing plenty of orders, and the works will be kept going with tolerable briskness for some months. Prices are extremely stiff, and a good export trade is being done, although competition is as keen as ever. Prospects, generally, are fair; the orders in view promise a continuance of the present activity for some time. The recently reported rise of 1.50f. for semi-finished steel for the next quarter has been followed by advances for some sorts of pig iron. The blast furnace works of Halauzeg and Musson have raised their foundry pig 2.50f. p.t. In the Charleroi district 69f. p.t. have also been paid for foundry pig, 60f. for forge pig, and 66f. to 67f. p.t. for basic. Bars are in good call at the basis price of £5 p.t. Rails and girders sell freely as before, and plates are in vigorous demand for army and navy requirements.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. F. W. HIGHFIELD, consumer's engineer in the Worcester Electricity Department, has been appointed showrooms assistant to the Birmingham Electric Supply Department.

WE are informed that Mr. E. C. Reed, chief publicity writer to the Westinghouse Companies' Publishing Department, has been appointed sales manager to Miles, Sykes and Sons, of Calder Works, Sowerby Bridge. Mr. Reed will take up his new duties early in the new year.

MR. F. B. O. HAWES, A.M. Inst. C.E., M.I.E.E., lately of Balfour House, Finsbury-pavement, London, E.C., and of the Electrical Trades' Benevolent Institution, informs us that his address is now 18, Park-mansions, Vauxhall Park, South Lambeth-road, London, S.W. Telephone number, Brixton 1833, and telegrams, "Nemawes, London."

MESSRS. HERBERT L. WETTERN AND FRED. R. WETTERN, hitherto trading as Blichfeldt and Co., of 16, Water-lane, Great Tower-street, E.C., inform us that for family reasons they have decided to convert the business in a private limited company, under the title of Wettern Brothers, Limited. There will be no change in the management of the business.

H. W. WARD AND CO., Limited, of Lionel-street, Birmingham, inform us that they have made arrangements with the purchaser of the freehold of the Lorraine-Dietrich Works, Bournbrook, for their occupation, to relieve the congested state of their present works, and afford greater facilities for the manufacture of their products. They are installing new machinery, and intend commencing operations immediately. Their head offices and showrooms will remain as before, in Lionel-street.

CALENDARS AND DIARIES FOR 1912.

A NEAT little pocket diary for 1912 has been forwarded to us by the Saxon Portland Cement Company, Limited, of Cambridge.—The Welin Davit and Engineering Company, Limited, of Hopetoun House, Lloyd's-avenue, E.C., has sent a new set of cards for use with the calendar issued by the firm last year.—From Henry Simon, Limited, of Manchester, we have received the usual excellent wall or desk calendar, with daily tear-off sheets.—A well-got-up wall calendar, with daily tear-off sheets, is to hand from the United States Metallic Packing Company, Limited, of Soho Works, Bradford, Yorks.—Hayward-Tyler and Co., Limited, of 99, Queen Victoria-street, E.C., has sent us the usual pocket diary. It takes the same form as diaries issued by the firm in previous years, and contains some useful memoranda which should prove of value to engineers associated with problems connected with the supply of water.—Two large wall calendars, with large monthly tear-off sheets, have been sent by the firm of George Cradock and Co., Limited, of Wakefield.—We have to acknowledge the receipt of a handsome combined desk blotting pad and calendar from Bruce, Peebles and Co., Limited, of Edinburgh. A reference book which is attached to this blotter contains abridged specifications and approximate price lists of the firm's manufactures, and also illustrations of Curtis turbo-alternators, motors, dynamos, &c. Many sheets of squared paper are also included in this book, and a memoranda slate is attached which is intended for calculations and jottings.—Merryweather and Sons, Limited, have forwarded an attractive wall calendar, with daily tear-off sheets.—A similar calendar is to hand from Urquhart, Lindsay and Co., Limited, of Blackness Foundry, Dundee. The card on which this calendar is mounted bears a photograph of an ancient Egyptian wheel gear.—A well-got-up wall calendar, with monthly tear-off sheets, is to hand from Alfred Herbert, Limited, of Coventry. It is printed on excellent paper, and each sheet bears a picture of some kind of machine tool.—A calendar got up on similar lines has also been forwarded by John Rogerson and Co., Limited, of Wolsingham, S.O., Co. Durham, the sheets in this case bearing pictures of large castings, &c.

CONTRACT.—J. W. Brooke and Co., Limited, Lowestoft, inform us that amongst recent orders received for "Brooke" motors is one from the Greek Government for six sets of 25 horse-power "Brooke" marine motors and full equipment of reverse gears, tail shafts, propellers, &c., for revenue boats. For the same boats six search-light plants, to consist of 4 horse-power "Brooke" motors with dynamos, necessary switchboards and 6000 candle-power projectors have also been ordered from the firm.

BRITISH PATENT SPECIFICATIONS.

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

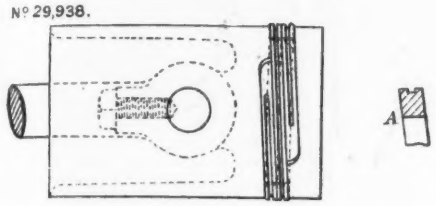
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of the Patent.

STEAM ENGINES.

29,938. December 23rd, 1910.—IMPROVEMENTS IN PISTONS OF ENGINES, PUMPS AND THE LIKE, J. Bonnet, of 442, Staniforth-road, Sheffield.

A helical groove is formed on the outer surface of the piston, and into this a helically coiled packing ring is sprung. Sufficien-

Nº 29,938.



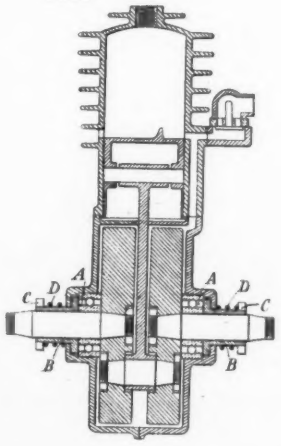
clearance is allowed between the ends of the packing ring and the ends of the groove to permit of expansion taking place. The surface of the packing ring is recessed, as shown in the cross section at A, for lubrication purposes.—*December 6th*, 1911.

INTERNAL COMBUSTION ENGINES.

2212. January 28th, 1911.—IMPROVEMENTS IN CRANK CASES FOR INTERNAL COMBUSTION ENGINES, Stuart Turner, Limited, 43, Market-place, Henley-on-Thames, Oxfordshire, and A. F. Plint, of "Pietersburg," St. Andrew's-road, Henley-on-Thames.

This engine is of the two-stroke cycle type, but the specification relates only to the manner of securing air-tightness in the crank case. The crank shaft and the weights attached thereto are

Nº2212



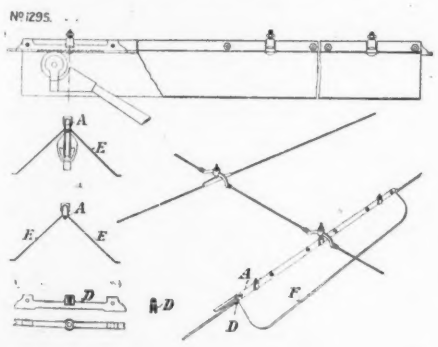
supported on ball bearings A fitting within recesses in the crank case. Flanged bushes B surround the shaft and project through to the outside of the casing. At their outer ends flanges C are screwed on. Between the outside flanges and the crank casing coiled springs D are interposed so as constantly to press the inner flanges of the sleeves against the inner faces of the crank case recesses. In this way air-tightness is secured without adding to the frictional resistance.—*December 6th*, 1911.

TRAMWAYS AND RAILWAYS.

1295. January 18th, 1911.—IMPROVEMENTS IN OR RELATING TO OVERHEAD ELECTRIC TROLLEY WIRES, John William Thompson, of Raglan-street, Lower Broughton, Salford, and James Finnigan, of Queen's-road, Cheetham-hill, Manchester.

This invention relates to an improved arrangement or device applicable to overhead electric wires by which the trolley wheel

Nº1295.



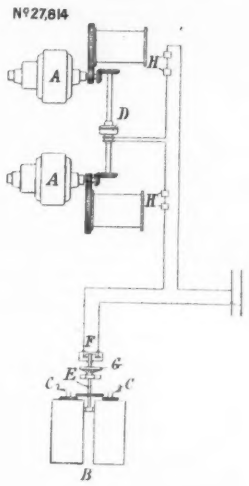
will be directed on to the wire when required to be replaced after being withdrawn therefrom, and will also prevent the trolley wheel leaving the wire. The invention consists of a metallic cover in the form of a ridge A for placing on and in electrical contact with a support D attached to the wire, and with the sides E of the cover depending down and splayed out, against which the trolley wheel will come into contact when being placed on the wire, and direct it on to the wire at the apex, and as the sides E are not insulated the car is lit up as soon as the trolley touches one of the sides, although the trolley may not have reached the wire. The appliance is constructed of sheet steel or other metal, the edges of the inclined sides F being curled or rolled over towards the outside to prevent the trolley wheel catching thereon, and the apex or ridge formed to rest upon a longitudinal support D which is sweated or otherwise secured to the live wire, the ridge being secured to the support by bolts.—*December 6th*, 1911.

DYNAMOS AND MOTORS.

27,814. November 30th, 1910.—METHODS OF SYNCHRONISING ELECTRIC OR OTHER MOTORS FOR USE ON CRANES, HOISTS, GUN TURRETS AND OTHER MACHINERY, Sir W. G Armstrong, Whitworth and Co., Limited, and Frank Harlow, both of Elswick Works, Newcastle-on-Tyne.

The illustration shows the invention applied to the control of electric motors. A separate motor A is provided for each separate set of gear. In the drawing each set of gearing is shown as transmitting motion to a winding drum. In the operating cabin or gun-house separate controlling mechanism B is provided for controlling each motor, each controller being operated by its own controller handle or lever C. The several sets of gear which are to be synchronised at will are connected by gearing, and between them is interposed an electro-magnetic clutch D, or it might be a mechanical or hydraulic clutch controlled by a lever or handle in

Nº27,814



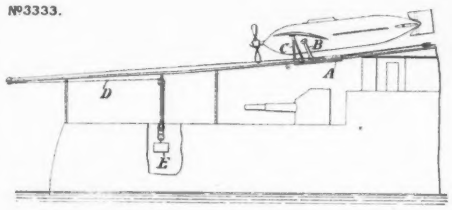
the operating cabin or gun-house. This lever or handle is also arranged to connect the controllers belonging to these sets of gear mechanically together so that when the several sets of gear are coupled together only one controller handle or lever needs to be operated. In the drawing this is shown to be effected by the shifting of a shaft E endwise. When shifted endwise a toothed wheel upon it can be brought into gear with a toothed wheel on the spindle of each controller, whilst at the same time an electric circuit is completed by contact mechanism F whereby the electro-magnetic clutch D is caused to couple the gear that is driven by one motor to the gear driven by the other. When they are thus coupled both controllers can be turned simultaneously by turning a hand wheel G which is fast on the shaft E. Before shifting the shaft E endwise both controllers are set into corresponding positions. H H are interlocking switches to prevent the clutch D being put in operation if the motors are on different gears, or if one is in gear and the other out of gear.—*December 6th*, 1911.

AERONAUTICS.

3333. February 9th, 1911.—IMPROVEMENTS IN DEVICES FOR LAUNCHING OR STARTING AEROPLANES, Captain M. F. Sueter, Lieutenant F. L. M. Boothby, and Engineer-Lieutenant H. G. Paterson, all of H M.S. Hermione, Barrow-in-Furness.

The engraving shows the invention applied to the launching of an aeroplane from on-board ship. Two parallel downwardly inclined rails are supported from the deck, and on these a trolley A is arranged to run. This trolley is provided with arms B

Nº3333.



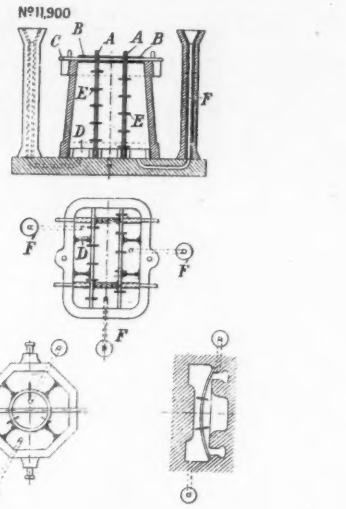
engaging trunnions projecting from the body of the aeroplane, and with arms C for supporting the wings. The launch is effected by the action of gravity on the aeroplane and trolley. As soon as sufficient velocity has been acquired the aeroplane tail is depressed, so as to cause the machine to rise free from its supports. A rope and weight, such as D E, may be used to assist the launch.—*December 6th*, 1911.

MINES AND METALS.

11,900. May 17th, 1911.—PROCESS FOR CASTING STEEL IN SEVERAL LAYERS, *Oliver Imray, of Birkbeck Bank Chambers, Southampton-buildings, London.*

It is proposed in this invention to form an ingot consisting of two or more layers of steel of different compositions. The layers are separated by sheets of soft iron, which become united to the metal on either side. The sheets are shown at A. They are held apart at the top by ferrules B on a rod C passing through the plates. At the bottom they are separated by distance pieces D. E E are small pins projecting from the plates to assist in the bonding. Vents F are provided, one for each division of the casting, and into these the various qualities of steel are poured simultaneously. Among other matters it is claimed that the presence

Nº11,900



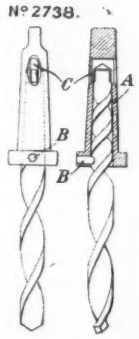
of a layer of soft iron between the layers of steel reduces the danger of breaking when a portion of the layers is exposed to stress.—*December 6th*, 1911.

MACHINE TOOLS AND SHOP APPLIANCES.

2738. February 2nd, 1911.—IMPROVEMENTS IN DRILLS, REAMERS, AND OTHER TOOLS HAVING TAPERED SHANKS, *J. T. Peddie, 22, Victoria-street, Westminster, London.*

The invention is shown applied to a "twisted" drill. The tapered sleeve or holder A is provided with an internal projection B. When the tool is turned on its axis in the direction of the

Nº 2738.



helix it tends to travel into the socket. A slot C is provided in the sleeve at its upper end to facilitate the dislodgment of the tool. If the tool has a solid shank, a helical groove may be milled in it to provide the necessary engagement for the projection B.—*December 6th*, 1911.

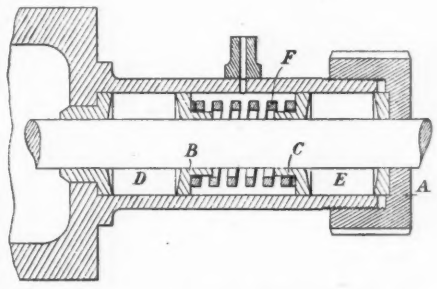
MISCELLANEOUS.

28,069. December 2nd, 1910.—A NEW OR IMPROVED INSULATING COMPOUND AND PROCESS OF PREPARING THE SAME, Orlando Venning Thomas, municipal electrical engineer, Penang, Straits Settlements.

The object of this invention is to produce an electrically insulating compound which has high di-electric properties which shall be plastic so as not to crack, whilst at the same time having sufficient solidity not to "run" when cold, which shall be waterproof, durable, and chemically inert in the presence of reagents sometimes existing in subsoil waters, and which shall retain these characteristics under all climatic extremes of temperature. Three ingredients are used—mica in a finely powdered state, resin preferably in a finely powdered state, and resin oil. The mica and resin are mixed in a dry state, and the oil is then added and the mixture heated in a suitable vessel. During heating the mixture is stirred, and when first heated it rapidly becomes fluid. On continuing the heating and stirring it becomes thick and pasty, and it must then be still further heated until it again becomes fluid, when it is ready to be poured off into barrels or other receptacles until required. When required for use the compound is heated to the fluid state in a boiler, such, for example, as the ordinary tar or bitumen boiler of the kind used in roadwork. Usually equal parts by weight of the three constituents are used.—*December 6th*, 1911.

6696. March 17th, 1911.—IMPROVEMENTS IN AND IN THE SEALING OF GLANDS FOR COMPRESSOR OR PISTON-RODS, *Thomas Forrest, of St. Aidans, Shotts, Lanarkshire.*

Nº6696.

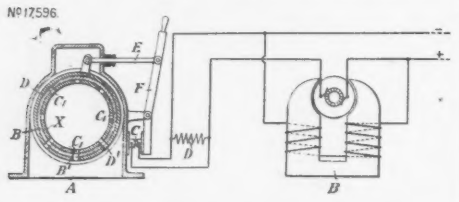


The stuffing-box is provided with a detachable cap A at the outer end, and inside it are arranged two sliding bushes B C.

Packing is introduced at D and E. The space between the bushes B C is fitted with a helical spring F, and with oil supplied under pressure from a pump. The device is particularly intended for the rods of CO_2 and other gas machines.—*December 6th*, 1911.

17,593. August 2nd, 1911.—IMPROVEMENTS IN SIGNALLING BY WATER SIRENS, *Neufeldt and Kupke, of 62, Holtenauerstrasse, Kiel, Germany.*

A is a siren shown in cross section through the drum and B is a motor which is coupled to the rotor of the siren by a belt or other mechanical means. C is a contact and D a resistance. The stationary parts of the siren are a casing which is open towards the surrounding water and a cylindrical casing B, in which a drum revolves, the drum being fed from one end with water under pressure. In the cylindrical casing B on the side turned towards the water there are openings B^1 and in the drum similarly disposed openings C^1. As these openings C^1 come into register with the openings B^1 the water is periodically discharged to the surround.



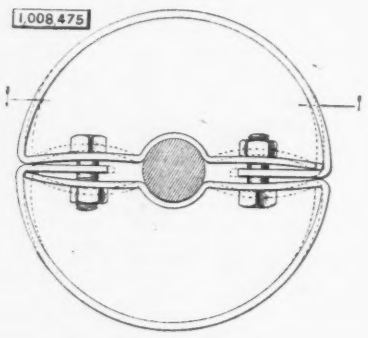
ing water and so produces a note in the known manner. The stationary cylindrical casing B is surrounded by a sleeve D, the openings D^1 of which register with the openings B^1 in the cylindrical casing B in the position shown. This sleeve D is connected by a link E with a lever F. When the lever is rocked the sleeve is rotated an amount equal to the width of the orifices B^1, so that the latter are closed and the siren is silent. The lever F is extended beyond its pivot and the arm formed by this extension carries a contact C, which is included in the armature circuit of the motor B and when closed short-circuits the compensating resistance D. If therefore the siren is silenced by operating the lever F, the power required from the motor is diminished. To maintain the speed constant, the armature current must be correspondingly decreased, and this is effected by inserting the compensating resistance D in the circuit. A modification is also described.—*December 6th*, 1911.

SELECTED AMERICAN PATENTS.

(From the United States Patent-office Official Gazette.)

1,008,475. PULLEY, *M. A. Kendall, Aurora, Ill., assignor to Stephens-Adamson Manufacturing Company, a Corporation of Illinois.—Filed December 27th*, 1910.

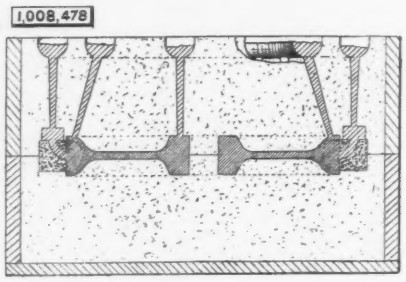
1,008,475



The drawing explains this invention. There are three claims.

1,008,478. PROCESS OF CASTING STEAM TURBINE WHEELS, &c., *W. T. Hopson, New London, Conn., and C. B. Rearick, New York, N.Y.—Filed March 11th*, 1911.

1,008,478

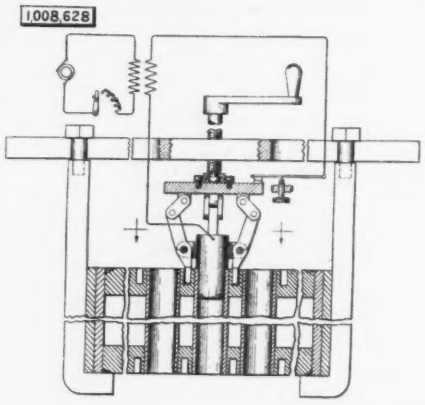


This patent is for a method of casting in sand moulds steam turbine wheels having thin cored peripheral partitions, which consists in pouring the metal into a circular distributing basin communicating through sprues with a heavy flow ring, in supplying the molten metal from this flow ring through runners to each of the thin partitions adjacent to the middle portion of its edge, to allow the metal to flow through these partitions during the casting operation to prevent chilling the metal entering the partitions, and to supply the adjacent portions of the casting, and in independently supplying metal to the casting. There are nine claims.

1,008,628. BOILER CONSTRUCTION AND MEANS FOR MAKING THE SAME, *C. A. Brown, Hinsdale, Ill., assignor, by mesne assignments, to the Steam Power Devices Company, Chicago, Ill., a Corporation of Illinois.—Filed August 1st*, 1910.

This invention is for welding in tubes electrically. This is done by grooving the tube plate between the flue openings, placing a

1,008,628

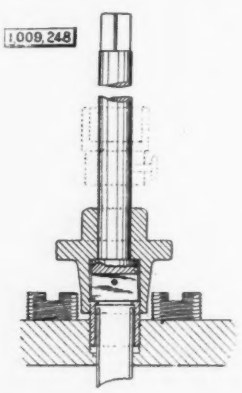


flue in one of such openings, placing clamping jaws in the grooves around the flue and a conducting plug in the flue, completing an electric circuit through the flue and head by means of the plug and clamps, and forcing the jaws and head in against the flue when the parts are at a welding temperature. There are twelve claims.

1,009,248. TOOL FOR WITHDRAWING AND INSERTING SCREWED FERRULES, *E. C. Jenkins and J. Jenkins, Birkenhead, England.—Filed November 3rd*, 1910.

The tool comprises a shank formed with a groove at one end, a cross bar removably mounted in the groove and projecting beyond

1,009,248

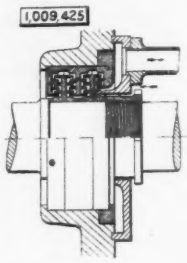


the end of the shank, and an internally screwed socket formed with grooves cutting across the screw threads mounted to rotate and move endwise on the shank and adapted to embrace the cross bar. There are six rather long claims.

1,009,425. SHAFT PACKING, *B. Ljungström, Stockholm, Sweden, assignor to Aktiebolaget Ljungströms Angturbin, Stockholm, Sweden.—Filed March 6th*, 1911.

This patent is for a turbine stuffing-box. The three claims are for the combination of a shaft, a casing in which the shaft is

1,009,425

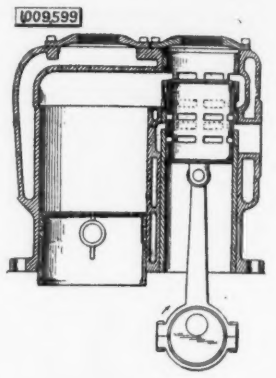


journaled, a chamber surrounding the shaft, said chamber having a contracted inlet communicating with the space between the shaft and casing, and a passage between the shaft and means whereby suction is created by fluid flowing through the inlet to the chamber.

1,009,599. VALVE FOR INTERNAL COMBUSTION ENGINES, *C. N. Teetor, Hagerstown, Ind.—Filed August 17th*, 1911.

This patent is for a sleeve valve. A stationary sleeve is fitted in the valve casing, and provided with delivery and exhaust ports, both arranged in alignment with a delivery passage. A hollow cylindrical valve is mounted to reciprocate in said sleeve, having ports leading from the interior to the outer surface thereof and adapted to register with the delivery ports in the sleeve when the

1,009,599

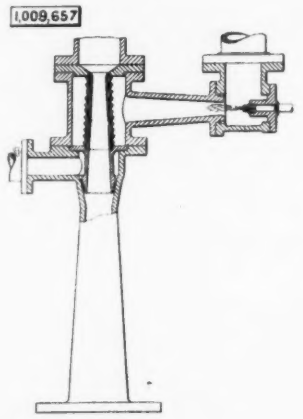


exhaust ports therein are closed by said valve; a ring is fitted closely around the valve, and adapted to be carried with it through a portion of its stroke, and means are provided to limit the movement of the ring to a fixed space, whereby the exhaust gases are prevented from passing into the body of the valve while the ports therein are passing the delivery ports in the sleeve on that stroke of the valve during which the compression and power strokes of the piston are taking place. There are twelve long claims.

1,009,657. JET CONDENSER, *R. N. Ekrhart, Pittsburgh, Pa., assignor, by mesne assignments, to the Colonial Trust Company, trustee, Pittsburgh, Pa., a Corporation of Pennsylvania.—Filed December 10th*, 1908.

In a condensing apparatus, a water jet, a centrifugal pump adapted to supply water conduit means connecting said device

1,009,657

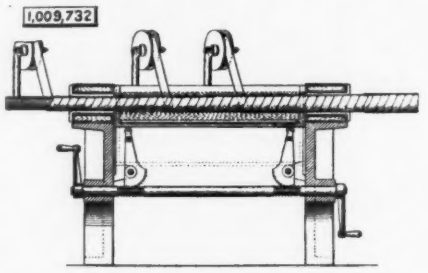


with the source of air to be removed, and a steam jet device adapted to raise the pressure of the air from said source prior to its entrance to said water jet device. There are two claims.

1,009,732. MACHINE FOR COVERING ELECTRICAL CONDUCTORS, *H. W. Fisher, Pittsburgh, Pa., assignor to Standard Underground Cable Company, Pittsburgh, Pa., a Corporation of Pennsylvania.—Filed March 20th*, 1911.

This patent is for the combination of a vertically moving insulating compound tank, a support for and forming the end

1,009,732



walls of the tank and provided with inlet and outlet orifices means for cooling the walls of the orifices, and means for moving the tank with reference to the support. There are three claims.

END OF VOL. CXII.

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JAN 16 1912

The Engineer.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. CXII.—No. 2922] LONDON: FRIDAY EVENING, DECEMBER 29, 1911 [PRICE SIXPENCE

Notice.—It Has Come to the

knowledge of the British Oxygen Co., Ltd., that plants for the production of Oxygen by the liquefaction of air have recently been offered for sale in this country.

NOTICE IS HEREBY GIVEN that the BRITISH OXYGEN CO., Ltd., are SOLE OWNERS of the LINDE BRITISH PATENTS for the Separation of Oxygen and Nitrogen from Liquid Air by means based on rectification. Their rights have been unanimously allowed by the final Court of Appeal after exhaustive litigation, the decision giving, in effect, to the Company very wide protection in the commercial production of oxygen and nitrogen from liquid air. 773

UNIVERSITY OF SYDNEY.

New South Wales, Australia.

ASSISTANT LECTURER AND DEMONSTRATOR IN MECHANICAL ENGINEERING.

APPLICATIONS are invited from qualified candidates for the above POSITION. Salary £250 per annum, rising by annual increments to £500 per annum. £60 allowed for travelling expenses to Sydney.

Particulars from the undersigned, to whom applications, stating age, and accompanied by four copies each of not more than five recent testimonials, should be sent not later than 10th January, 1912

AGENT-GENERAL FOR NEW SOUTH WALES.
123 and 125, Cannon-street,
London, E.C.,
18th December, 1911. 884

State of Nawanagar, India.

TENDERS are invited for the SUPPLY of 40 lb. STEEL RAILS and ACCESSORIES for 75 miles of railway now under construction, f.o.b. in British port.

The right is reserved to reject the lowest or any Tender.

Tenders to be addressed to the STATE ENGINEER, care of Redfern, Hunt and Co., Dauntsey House, Frederick's-place, London, E.C. 934

TO CRANE MAKERS.

The Dublin Port and Docks

BOARD is prepared to receive TENDERS from crane makers for

TWO ELECTRIC FOUR-TONS PORTAL WHARF CRANES.

The specification, together with a special form of tender, can be obtained at the Office of the Engineer of the Board, Sir John P. Griffith, M. Inst. C.E., East Wall, Dublin, on payment of One Pound (which will be refunded to firms sending in bonâ fide tenders).

Tenders, with contractor's supplemental specification and drawings, marked on the outside of the cover "Tender for Electric Wharf Cranes," must be delivered by post, sealed, prepaid, and addressed to the Secretary, Port and Docks Office, Westmoreland-street, Dublin, on or before Tuesday, the 30th day of January, 1912.

The Board does not bind itself to accept the lowest or any tender.

By Order,
N. PROUD, Secretary.

Dublin Port and Docks Office,
9th December, 1911. 875

The Great Indian Peninsula

RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

Rails and Fishplates.	Locks, &c.
Fishbolts and Nuts.	Metals.
Cast Iron Chairs.	Station Bells, Bib Cocks, &c.
Helical and Volute Springs.	Ropes, Twines, &c.
Laminated Springs.	Plate Glass, &c.
Wheels and Axles.	Plumbago Crucibles.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

Tenders must be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Rails and Fishplates," or as the case may be, not later than 11 o'clock a.m. on Thursday, the 4th January, 1912.

The Directors do not bind themselves to accept the lowest or any Tender.

J. I. BERRY,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C.,
London, 22nd December, 1911. 935

VACANCIES FOR ENGINEERS.

Applications are Invited for

THREE VACANCIES for ENGINEERS in the Irrigation Department, Pretoria, South Africa, on the following terms :—

(a) Applicants must be between the ages of 27 and 35 years.

(b) Applicants must have had practical experience on engineering survey works (including the use of the tacheometer) and on the construction of works for the utilisation of water.

(c) Applicants must have had a good theoretical training.

(d) The salaries offered are from £500 to £600 per annum by annual increase over three years, with the usual travelling and subsistence allowance payable under the Civil Service Regulations from time to time in force, and accepted applicants will be required to enter into a contract with the Department for a term of three years from the date the applicants report for duty in Pretoria.

(e) Accepted applicants will receive salary from the date of embarkation in England, and will be furnished with a first-class ticket from an English port to Pretoria, and with a return ticket at the end of the three years' period, provided that at the end of that period he desires to return to England.

(f) All applications must be made on a form to be obtained from the High Commissioner for the Union of South Africa, and delivered at his office, 32, Victoria-street, Westminster, London, S.W., not later than noon on the 15th January, 1912.

(g) Applications should be sent in a sealed envelope addressed to "The HIGH COMMISSIONER for the UNION of SOUTH AFRICA, 32, Victoria-street, Westminster, London, S.W.," and marked "Application for Employment in Irrigation Department, South Africa." 950

North Bromsgrove Urban

DISTRICT COUNCIL.
BARNT GREEN SEWERAGE.
CONTRACT No. 1.
CLERK OF WORKS.

APPLICATIONS are invited for the POSITION of CLERK of WORKS on the above contract, which will commence about end of January, and will last about 3 months only.

Applicants must be capable of using a dumpy level accurately, and of setting out work, &c.

Applications, stating age, experience, and salary required, with copies of not more than three recent testimonials, to be sent to Mr. Robert Green, M. Inst. C.E., 37, Waterloo-street, Birmingham.

P. LEVENS,
Clerk to the Council.

Bromsgrove,
December, 1911. 941

Ribble Navigation and Preston

DOCK UNDERTAKING.

The Corporation of Preston REQUIRE the SERVICES of a DREDGING SUPERINTENDENT to act under the direction and control of the Ribble Engineer.

Applicants should have practical experience of the working of bucket dredgers, sand pumps, hoppers, and other dredging plant, and the management of men, and should be prepared to attend all working tides.

The salary is £300 per annum.

Canvassing directly or indirectly will be a disqualification.

Applications, endorsed "Dredging Superintendent," stating age and experience, with copies of three recent testimonials, to be sent to the undersigned not later than Wednesday, the 3rd January, 1912.

ALFRED HOWARTH,
Town Clerk,

Town Hall, Preston,
20th December, 1911. 905

Dredging Superintendent.—The

Tyne Improvement Commissioners REQUIRE the SERVICES of a competent person to discharge the duties of DREDGING SUPERINTENDENT.

Salary £250 per annum.

Applications, stating age, present occupation, and past experience, and accompanied by three recent testimonials, to be sent in to the undersigned under cover, marked "Dredging Superintendent," not later than noon on Friday, the 5th January proximo.

The person appointed will be responsible under the Engineer for superintending the whole of the dredging carried out by the Commissioners in the River Tyne, including the movements of the river craft connected with the dredging work.

Further information as to the duties can be obtained on application.

Personal canvassing will be a disqualification.

By order,
J. McDONALD MANSON,
General Manager and Secretary.

Tyne Improvement Commission Offices,
Newcastle upon-Tyne,
21st December, 1911. 908

Rangoon Municipality, Burma.

APPLICATIONS are invited for the APPOINTMENT of ASSISTANT ENGINEER in the Public Works Department of the Rangoon Municipality.

Applicants must have a thorough experience in the construction of roads with various materials and the maintenance thereof, in water and sewage engineering, in building design, construction, and maintenance, and the preparation of drawings, estimates, and reports; they must also be capable of supervising efficiently a staff of overseers, &c

Preference shall be given to candidates who, in virtue of having obtained a diploma or degree in Engineering, are recognised by the Institution of Civil Engineers or the Institution of Municipal and County Engineers, or have obtained a University degree or a diploma or other distinction in Engineering equivalent thereto, or who hold a certificate that they have passed the final examination of the Civil Engineering course at the Thomason Civil Engineering College, Roorkee, or any other Engineering College approved of by the Committee.

In addition, candidates should have at least 3 years practical experience in engineering works.

Applicants must not be under 27 years or over 40 years of age.

The appointment will be, in the first instance, for a period of three years, on a salary of Rs. 600/ per mensem.

Applicants must pass a medical examination by a medical officer appointed by the Municipal Committee or its agents.

The successful candidate will be required to sign an agreement, and will be required to subscribe towards the Municipal Provident Fund, according to the by-laws in force from time to time.

Leave and leave allowances will be granted in accordance with the rules in force for the Indian Services of the Government.

No exchange compensation or other allowances will be granted.

Applications, with certificated copies by the applicants of three recent testimonials, should reach the undersigned not later than the 24th January, 1912. They will be sent out to Rangoon by mail, where the selection will be made by the Municipality, and all applicants informed of the result in due course.

A first-class free passage out by the Bibby Line of steamers will be allowed to the successful candidate to join his appointment, and half pay will be granted during the voyage.

On termination of the appointment according to the provisions of the agreement, a like free passage will be granted should the candidate appointed intend to return to Europe.

The successful candidate will be required to enter upon his duties within one month from the date of receiving notice of the appointment.

For further particulars apply to
OGILVY, GILLANDERS and CO.,
Agents for the Rangoon Municipality.

R. 1349, 67, Cornhill, London, E.C. 879

Wanted, Foundry Expert, but

not as Foreman (Brass and Iron); small but high-class output, steam and hydraulic work, plate and machine work; knowledge of machining and finishing an advantage. Educated man to assist in management and to work shop hours. Manchester district.—Address, full particulars, salary required, to 932, Engineer Office, 33, Norfolk-street, Strand, W.C. 932 A

Wanted, Works Manager for

large Locomotive Shop. None but first-class experienced and energetic locomotive engineers need apply. Give full particulars of past experience, references (copies only), and salary expected.—Address, P992, Engineer Office, 33, Norfolk-street, Strand, W.C. P992 A

Winding Charge Hand Wanted

by Manufacturers of Dynamos and Motors in Manchester district. Must have had previous experience as charge hand. State age and salary required.—Address, 921, Engineer Office, 33, Norfolk-street, Strand, W.C. 921 A

A Leading Firm of Machine

TOOL MAKERS
REQUIRES the SERVICES of a FIRST-CLASS DESIGNER.

Previous experience in the Design of Automatics, Semi-automatics, and Turret Lathes will be a recommendation, but originality, combined with soundness in design, is an essential qualification for the post, which offers good prospects to the right man.

Address, 916, Engineer Office, 33, Norfolk-street, Strand, W.C. 916 A

Cement Works, Malay Peninsula.

—WANTED, MANAGER for Cement Works; also TWO BURNERS and an ENGINEER. Only thoroughly good men wanted.—Address, stating past experience and salary expected, to 926, Engineer Office, 33, Norfolk-street, Strand, W.C. 926 A

Electrical Manufacturing Co.

REQUIRE WORKS SUPERINTENDENT. Applicant must be of good education and technical training, strict disciplinarian, and have exceptional experience in the latest workshop practice in the economical production of large quantities of accurate repetition work. Good opening for really capable man.—Address, in confidence, giving full details of age, experience, and salary required, to 929, Engineer Office, 33, Norfolk-street, Strand, W.C. 929 A

Engineer Wanted, with Special

knowledge and experience of Electric Lift Business. Must have good connection among architects and engineers. Will be expected to secure orders, supervise estimates and contracts.—Write E. E., care of J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 938 A

Presstool Designer Wanted;

must have first-rate experience in design of small and medium size Presstools, drawing and combination tools for Brass and Welsh Tinplate, and be capable of making drawings of his own design and supervise toolmakers' shop.—Address, giving full references, and state salary required, to 925, Engineer Office, 33, Norfolk-street, Strand, W.C. 925 A

Wanted, an Experienced

DRAUGHTSMAN; must be accustomed to the design of Press Tools as used in the Manufacture of Electrical Machinery, and able to lay out formers for winding armature and stator coils, &c.

Apply, stating age, experience and salary required to
SIEMENS BROTHERS DYNAMO WORKS, Limited,
Stafford. 944 A

Wanted, Draughtsman for Com-

MERCIAL and Motor Work, with experience of Chassis and Engine Design.—Application, stating age, experience, and salary required, and date when free, to J. and E. HALL, Ltd., Dartford. 936 A

Chief Draughtsman Wanted by

a Firm of Machine Tool Makers, in the North of England, who make heavy lathes; planing and boring machines a speciality. A good position to a thoroughly capable man experienced in the latest practice is offered.—Address in first instance, in confidence, stating experience and salary expected, to 942, Engineer Office, 33, Norfolk-street, Strand, W.C. 942 A

Draughtsman Wanted, About

25, accustomed Steam Engines and general arrangements. Knowledge refrigeration advantageous.—Reply, with full particulars, P999, Engineer Office, 33, Norfolk-street, Strand, W.C. P999 A

Draughtsman Wanted; Must be

thoroughly up to date, and fully experienced in High-speed, Drop and Corliss Valve Steam Engine Design, and General Work for modern engineering shops; permanency offered to competent man.—State age, experience, references, and salary, to 821, Engineer Office, 33, Norfolk-street, Strand, W.C. 821 A

Draughtsman Wanted; Must be

thoroughly up to date and fully experienced in high-class Steam Engines and Refrigerating Machinery. Good opening for competent man.—State age, experience, references, and salary, to 917, Engineer Office, 33, Norfolk-street, Strand, W.C 917 A

Rhodesia. — Junior Draughts-

MAN WANTED (not above 25), to join the Rhodesian establishment of an English Company. Experience with Survey and Map Work an advantage, and must have knowledge of shorthand and Typewriting. Salary £200 first year, £240 second year. Free passage and quarters provided. Will be required to leave as soon as possible.—Address, in first instance, stating briefly experience, to D. H., care of Street's, 30, Cornhill, E.C. 949 A

The British Westinghouse Elec-

TRIC and MANUFACTURING CO., Limited, thank those who replied to their advertisement P923A of the issue of December 8th. The VACANCIES for DRAUGHTSMEN are now FILLED. P995 A

Winding Foreman Wanted by

Manufacturers of Dynamos and Motors in Manchester district. Must have had previous experience as Foreman. State age and salary required.—Address, 920, Engineer Office, 33, Norfolk-street, Strand, W.C. 920 A

Wanted, Foundry Foreman, to

turn out 60 tons weekly of sound high-class Castings in dry, green sand and loam. Able also to control the shop, and effect economies by the introduction of up-to-date methods. No applications will be considered except from men holding similar positions.—Full particulars in confidence to 924, Engineer Office, 33, Norfolk-street, Strand, W.C. 924 A

Foreman Wanted for the Motor

and Dynamo Assembly Department by an Electrical Manufacturing Firm in the Manchester district. State age and salary required.—Address, 919, Engineer Office, 33, Norfolk-street, Strand, W.C. 919 A

Gas Engine Salesmen.—Kynoch

Limited, Birmingham, REQUIRE the SERVICES of TWO experienced SALESMEN—one for the North of England and the other for London district. Only men who have specialised in Gas Engines, and have been successful, should apply.—Application, giving experience and salary required, should be made by letter only. 948 A

Paris. — Assistant Engineer-

SALESMAN REQUIRED by English firm for their Paris office. Must speak French fluently, be trained engineer, and have had travelling experience, but not necessarily in France. Moderate commencing salary with good prospects to right man. Please give full particulars with your application.—Address, 819, Engineer Office, 33, Norfolk-street, Strand, W.C. 819 A

Vacancy for Traveller with a

large firm of Lubricating Oil and Chemical Manufacturers. Liberal salary and commission to one with a sound connection.—Address, P983, Engineer Office, 33, Norfolk-street, Strand, W.C P983 A

Wanted, an Engine-driver, to

Take Charge of Portable Engine and General Brickfield Gear. Good wages to reliable man.—Apply, with references, to E. B. REED, Brickworks, Iver, Bucks. 945 A

Wanted, Fitters; None but

first-class men experienced on Rotary Newspaper Presses need apply. Good men can count on steady positions and good pay. 53 hours weekly. New modern works situated nine miles from London on the Great Western main line. Give full particulars with your application and references.—Address, THE GOSS PRINTING PRESS COMPANY OF ENGLAND, Limited, Hayes, Middlesex. 874 A

Mechanic Wanted for Brazil, to

Re-erect Cottonseed Crushing Machinery and to keep it in working order for some months. Should have previous experience. Plant includes a decorticator.—Address, in first instance, P967, Engineer Office, 33, Norfolk-street, Strand, W.C. P967 A

Chief Engineer (Marine), First-

CLASS experience, SEEKS POSITION with Superintendent or Consulting Engineer. Investment entertained.—Address, P941, Engineer Office, 33, Norfolk-street, Strand, W.C. P941 B

Engineer and Draughtsman (34)

SEEKS ENGAGEMENT; 14 yrs.' experience, including shops, gas and oil engines, motor chassis, gearing, and paper mill experience.—SMITH, care of Pott, High-street, Saxilby, Lincs. P985 B

Refrigerating Engineer, at

present chief of large cold stores, is OPEN to IMPROVE his POSITION; 17 years' experience with CO_2 and ammonia compressor systems, steam, gas, and electrically driven. Considerable knowledge and experience of motor traction and general engineering. Principals only.—Address, P1000, Engineer Office, 33, Norfolk-street, Strand, W.C. P1000 B

Young Engineer (25), First-class

B. of T. Certificate, SEEKS POSITION in any capacity. Good testimonials.—Address, P994, Engineer Office, 33, Norfolk-street, Strand, W.C. P994 B

Draughtsman (30), London; 7

years shops, all-round experience, including patents.—Address, P1, Engineer Office, 33, Norfolk-street, Strand, W.C. P1 B

Mechanical Draughtsman (24),

with electrical experience and 3 years shops, would TAKE CHARGE of DRAWING-OFFICE or ASSIST ENGINEER.—Address, P997, Engineer Office, 33, Norfolk-street, Strand, W.C. P997 B

An Engineer, with Considerable

practical and commercial experience, open for ENGAGEMENT as TRAVELLER. Could start immediately. Highest references to character and capacity.

Address, P993 Engineer Office, 33, Norfolk-street, Strand, W.C. P993 B

Lifts, Hand, Hydraulic, Electric.

—SITUATION WANTED as REPRESENTATIVE for London, Midlands, South or South Western districts, by expert in all branches of competitive design and manufacture.—Address, 946, Engineer Office, 33, Norfolk-street, Strand, W.C. 946 B

A Leading Firm of Engineers

in Yorkshire, making Internal Combustion Engines, Gas Producers, Crankshafts, &c., have VACANCIES for several PREMIUM APPRENTICES.—For particulars address 599, Engineer Office, 33, Norfolk-street, Strand, W.C. 599 B

A West of England Firm,

making Gas and Oil Engines, have a VACANCY for PREMIUM PUPIL.—Address, 2038, Engineer Office, 33 Norfolk-street, Strand, W.C. 2038 B

Assoc. M. & Stud. Inst. C.E

EXAMS. both Oct. and Feb.; also for B.Sc., P.W.D., India, &c., with all Mech. and Elect. Eng. taught in 6, 5, or 3 months' courses by post.—Write, Prof. JAMIESON, M. Inst. C.E., &c., at once, to Kelvinside, Glasgow, W., for Prospectus and Terms. Special facilities for those abroad. 478 I

Engineering Pupil. — Firm

(Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 2000, Engineer Office, 33, Norfolk-street, Strand, W.C. 2000 B

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EXAMS.—CORRESPONDENCE COACHING by a practical Civil Engineers. Successes number 155 out of 173 sent in to date (30 successes Feb. and Oct., and Bayliss prize). Course in reinforced concrete. Special features for foreign candidates. Send for booklet, &c.—Address, 765, Engineer Office, 33, Norfolk-street, Strand, W.C. 765 I

Engineering Correspondence

TUTORS (Estab. 1878).—A.M.I.C.E. & B.Sc., P.W.D. San. Inst.; Stud. I.C.E., Surveyors' Inst., Matric. Exam. Aids, 1s. each subj.—PENNINGTONS, 254, Oxford-rd., Manchester P144 I

Inst. C.E. and all Engineering

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Thorough Tuition in BRIDGEWORK of all types, ROOFS of all descriptions, BUILDINGS on the American and Continental plan, &c. Send for Descriptive Booklet E (6th Edition), free on request. 711 I

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To Engineers Going Abroad and

OTHERS.—Exceptional opportunity to ACQUIRE PRACTICAL INSTRUCTION in SURVEYING, LEVELLING, &c., on varied and extensive Surveys.—Address, P583, Engineer Office, 33, Norfolk-street, Strand, W.C. P583 I

German Mechanical Engineering

Firm (manufacturing copper and metal packing rings and also stuffing-box packings) REQUIRES active AGENT for ENGLAND.—Apply, K.S. 6902, care of Rudolf Mosse, Cologne. 873 D

For Partners and Partnerships

in Mechanical, Electrical, Foundry, Marine, Constructional, Agricultural, Motor, Consulting, Merchant, and other Branches of ENGINEERING apply to—

WHEATLEY KIRK, PRICE & CO.,
Engineers and Valuers
46, Watling St., London, E.C.;
16, Albert Square, Manchester
36, Collingwood-street, Newcastle-on-Tyne.
ESTABLISHED SIXTY YEARS. Spl 3005

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a number of proved valuable patents, are desirous of meeting with a Firm of General Engineers, of established reputation, with the ultimate object of a JOINT FLOTATION. Strictly confidential.—Address, in the first instance, to P991, Engineer Office, 33, Norfolk-street, Strand, W.C. P991 C

Alfred Towler, M. Inst. Mech. E.,

Specialist in Pumping Machinery, 25 years chief draughtsman and works manager for Messrs. Hathorn, Davey and Co., Ltd., Leeds, terminates his agreement with them at Christmas, Desires Partnership in Works, Consulting Business, Engineer, or General Manager.—Address, Brookroyd, Ilkley. 1011 C

Engineering Partnerships, Direc-

TORSHIPS, &c.—We have Engineers with capital available from £1000 to £10,000 requiring INVESTMENTS chiefly with occupation, in well-established sound engineering or allied businesses, London and Provinces. No result, no commission.—Apply for terms or list post free (3d.), Messrs. ARNOLD and CO., 76, Cannon-street, London, E.C. Estab. 1891. 930 C

SMALL ADVERTISEMENTS

SITUATIONS, FOR SALE, &c.

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Numerical Index to Advertisements, PAGE LXIX.

Subject-Matter Index to Advertisements, PAGE LXXI.

Engineer (27), with £3000 and mechanical and some electrical experience, REQUIRES PARTNERSHIP or ACTIVE DIRECTORSHIP in a well-established Engineering, Motor, or Haulage Contractor's Business, London or Provinces.—Particulars to ARNOLD and CO., above. 931 c

Partner with £5000 Required in Motor and Garage business in the East by firm already well established and now selling cars. Good profits. No serious competition. Will suit commercial man or engineer. —Particul rs from Messrs. ARNOLD and CO., 76, Cannon-street, London, E.C. 947 c

TO MANUFACTURERS OF TICKET-ISSUING APPARATUS AND MANAGERS OF BOX OFFICES.

The Proprietor of Patent No. 934 of 1910 is DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES to MANUFACTURERS on royalty or otherwise, or to treat for the SALE of the PATENT outright.
Particulars will be furnished on application by :—
A. M. AND WM. CLARK,
53, Chancery-lane,
London, W.C. 892 n

TO HAT-PIN MANUFACTURERS.

The Proprietor of Patent No. 16,700 of 1909 is DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES to MANUFACTURERS on royalty or otherwise, or to treat for the of the PATENT outright.
Particulars will be furnished on application by :—
A. M. AND WM. CLARK,
53, Chancery-lane,
London, W.C. 891 n

The Proprietor of British Patent No. 254 of 1908, relating to a PROCESS for PURIFYING BLAST FURNACE, GAS PRODUCER, COKE OVEN, and other GASES, is DESIROUS of ENTERING into ARRANGEMENTS with British Manufacturers with a view to the SALE or COMMERCIAL EXPLOITATION of the INVENTION protected by the above Letters Patent.
The object of the invention is to purify the gases, with a view to the recovery of their by-products. The gases are caused to be scoured, after being freed from coarse impurities, by a spray, produced by an atomiser, located in a restricted passage at the top of a vertical column, the gases being drawn through this passage and effectively cleaned while descending the column.
Interested parties are invited to communicate with the undersigned for further particulars.
HENRY SKERRETT,
Chartered Patent Agent,
24, Temple-row, Birmingham. 918 n

APPARATUS FOR AUTOMATICALLY REGULATING FURNACE DRAUGHT. No. 14,430 of 1909.

The Patentee is Desirous of ARRANGING by LICENSE or otherwise on reasonable terms for the MANUFACTURE and COMMERCIAL DEVELOPMENT of the INVENTION in this country.—HERBERT HADDAN and CO., Patent Agents, 31-32, Bedford-street, Strand, London, W.C. 922 n

The Proprietors of the Patent No. 27,160, A.D. 1904, entitled "ROLLING MILLS FOR MANUFACTURING ARTICLES, such as Railing Heads, Studs and the Like," DESIRE to GRANT MANUFACTURING LICENCES to manufacturers of such machinery.—Address, C. LEAN, 231, Strand, London, W.C. P988 n

The Proprietor of the Patent No. 28,836, A.D. 1902, entitled "IMPROVEMENTS IN PRESSES FOR MOULDING FUEL BRIQUETTES," DESIRES to GRANT MANUFACTURING LICENCES to manufacturers of such machinery.—Address, CLEMENT LEAN, 231, Strand, London, W.C. P989 n

A Firm of Engineers, having an exceptional connection among the leading railways (British, Indian, and Colonial) is PREPARED to CONSIDER, with a view to Undertaking their Manufacture and Sale, any SUITABLE SPECIALITIES.—Communications, which will be treated in strict confidence, to be sent, in the first instance, to 2003, Engineer Office, 33, Norfolk-street, Strand. W.C. 2003

Wanted, a Good Second-hand PLANING MACHINE.—Apply, H. R. STEVENS, West Quay, Southampton. P980 r

Wanted, First-class Second- HAND 12in. centre S.S.S.S. LATHE, gap bed, machine cut gear, about 22ft. between centres.
18in. ditto, about 14ft. between centres, admit 5ft. in gap.
HEAVY PLANER, about 12ft. × 4ft. 6in. × 4ft. 6in.; two tools; quick return. State age, make, and where can be seen. Send illustrations.—Address, 940, Engineer Office, 33, Norfolk-street, Strand, W.C. 940 r

Wanted, Good Working Second- HAND DRYER, for wet grains. State price.—Apply, EDWARD FISON, Ltd., Maltings, Ipswich. P986 r

Wanted, Steam Engine, Verti- CAL, 200 to 250 I.H.P., non-condensing. Must be of first-class make and condition. Give full particulars and price.—Address, 943, Engineer Office, 33, Norfolk-street, Strand, W.C. 943 r

Wanted, Three Lancashire BOILERS, 30ft. by 8ft. or 30ft. by 7ft. 6in. for 100 to 120, steam pipe connections.—A. UNDERWOOD, 3, Queen-street, E.C. 939 r

One Kilowatt Engine and DYNAMO WANTED, Second-hand; must be good condition; both or separately.—Write price and full particulars to Z. E. 746, care of Deacon's Advertising offices, Leadenhall-street, London. 933 r

Fielding & Platt, Ld., Gloucester.
SPECIAL BARGAINS.
COMPOUND CONDENSING DUPLEX PUMPS, two high-pressure, cylinder 14in. diameter, pump rams 8in. diam., all working 18in. stroke. JET CONDENSERS, capacity 20,000 gallons per hour. ONLY £240.
LANCASHIRE BOILER, 28ft. × 7ft., insure 90 lb.
VERTICAL INVERTED STEAM ENGINE, 100 I.H.P.
NEW FOUR-CYLINDER VERTICAL FIELDING GAS ENGINE, 150 B.H.P., for quick delivery. Y344

Boilers and Machinery (Good Second-hand) for SALE. Please send us your inquiries, as we carry a large stock.—JOHN STRINGER and SON, Dept. 3, Blackburn. 2034 o

For Hire or Sale, 40 N.H.P., Portable STEAM ENGINE, 25 H.P., 20 H.P. Ditto, and Smaller Sizes to 6 H.P. STEAM BOILERS, MORTAR MILLS, PUMPS, CRANES, ELECTRICAL PLANTS, &c., reasonable terms and immediate delivery.—J. T. WILLIAMS and SONS, 73, Queen Victoria-street, London. LW 3936 2012 o

For Hire, Pumps and Well- BORING TOOLS for Contractor's Deep Wells, &c., 3in. to 24in. diam.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 822 o

For Immediate Delivery :—
4 SENSITIVE DRILLING MACHINES.
6ft. and 7½ft. RADIAL DRILLING MACHINES.
5in., 6½in., and 7½in. S.S.S. LATHES.
SLOTTING MACHINES, 4in. to 14in. stroke.
2 HORIZ. BORING MACHINES.
3 VERTICAL MILLING and PROFILING MACHINES.
JAMES SPENCER and CO.,
Chamber Ironworks, Hollinwood, Manchester. Q413 o

For Sale :—
New 14in. by 20in. Four or Six-wheels coupled SADDLE-TANK LOCOMOTIVES.
Immediate delivery.
THE AVONSIDE ENGINE COMPANY LTD.,
Bristol. Y940

For Sale, a Stanley's 6in. THEODOLITE, for mining and other purposes, fitted with illuminated axis, lamp, &c., diagonal eye-piece, striding level, and usual fittings. Both circles are divided on silver, and read to 20 seconds.
Also MAHOGANY TRIPOD, with G.M. fittings and 15ft. levelling staff in three heights.
Has only been used but few times, and is practically as good as new.
Owner has no use for it, which is sole reason for sale.
Apply, W. R. MEE, Barton-under-Needwood, near Burton-on-Trent. P960 o

For Sale, Hire, or Purchase- HIRE :—PORTABLE ENGINES, 5 to 25 N.H.P.
ROAD LOCOMOTIVES, 6 to 8 N.H.P.
TRACTION ENGINES, 6 to 8 N.H.P.
TRACTION WAGONS, 6 to 10 tons.
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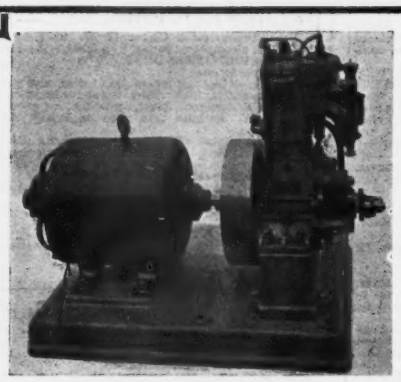

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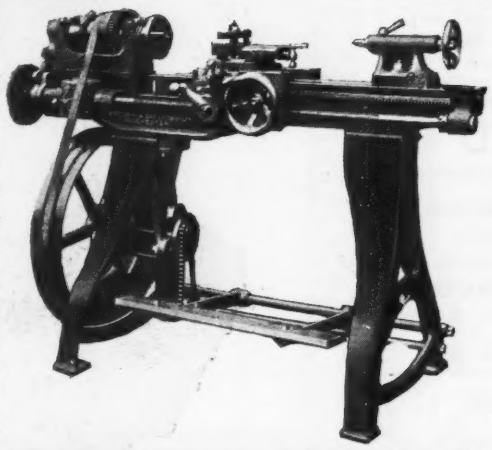

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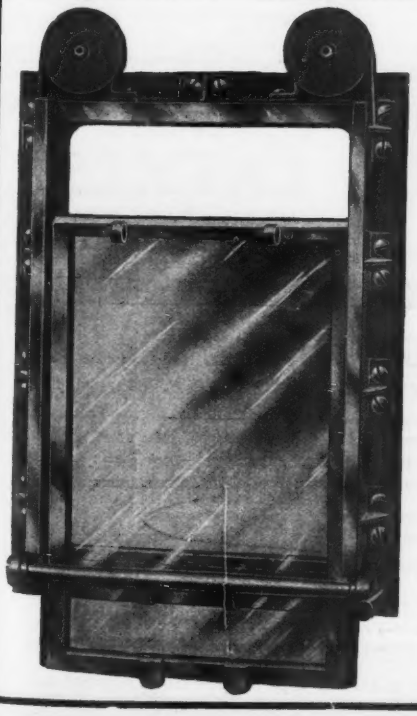

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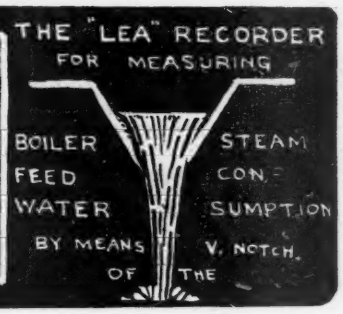

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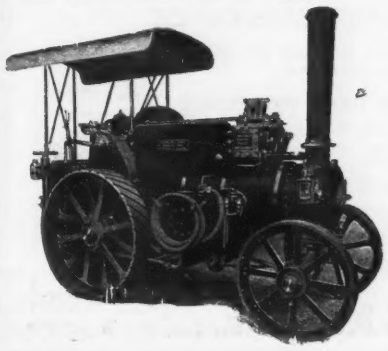

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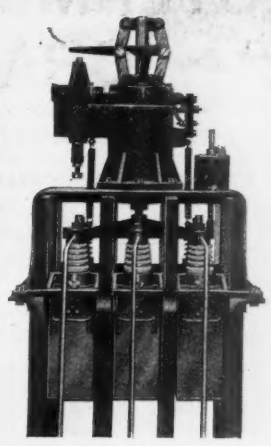

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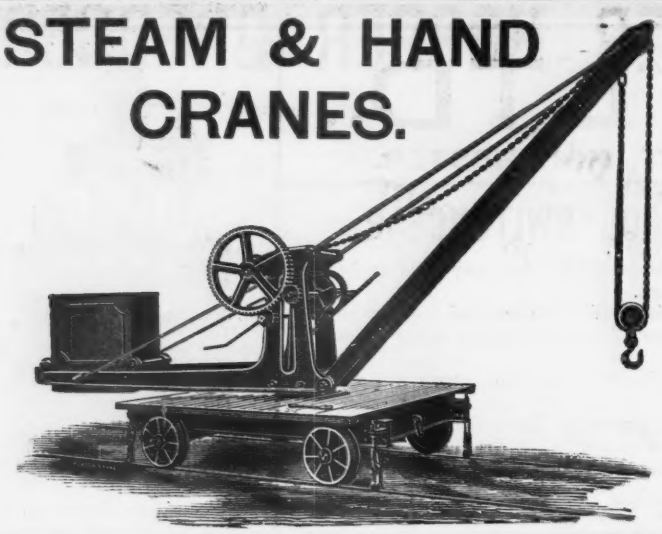

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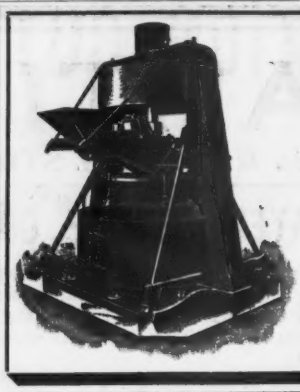

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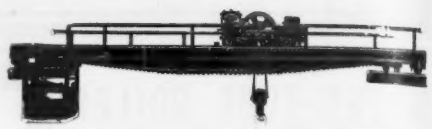

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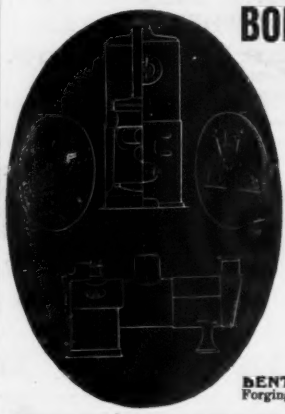

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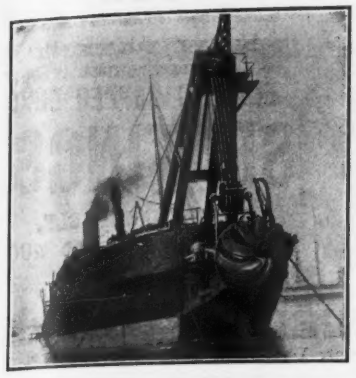

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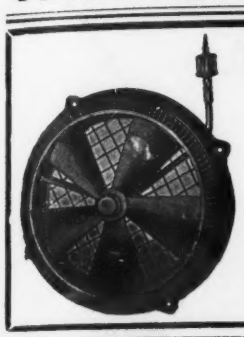

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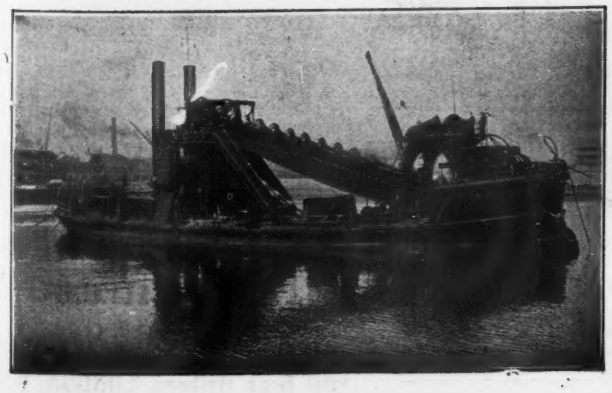

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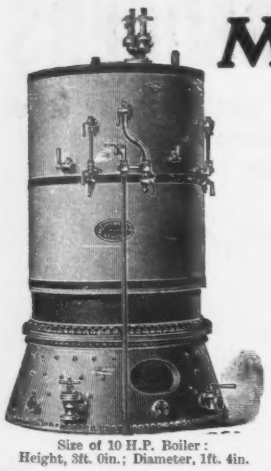

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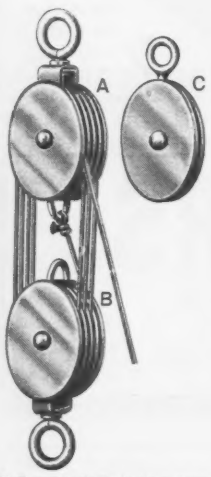

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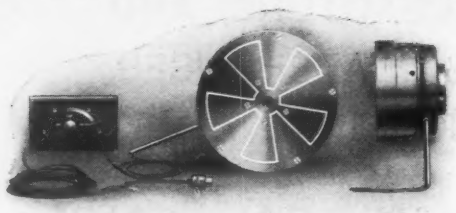

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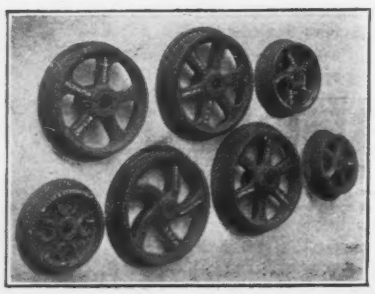

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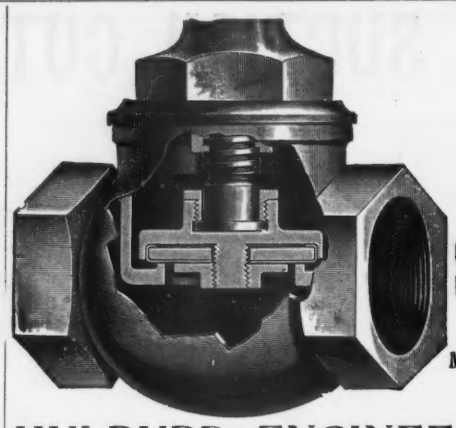

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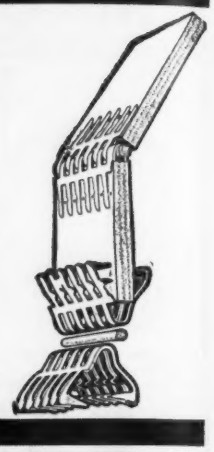

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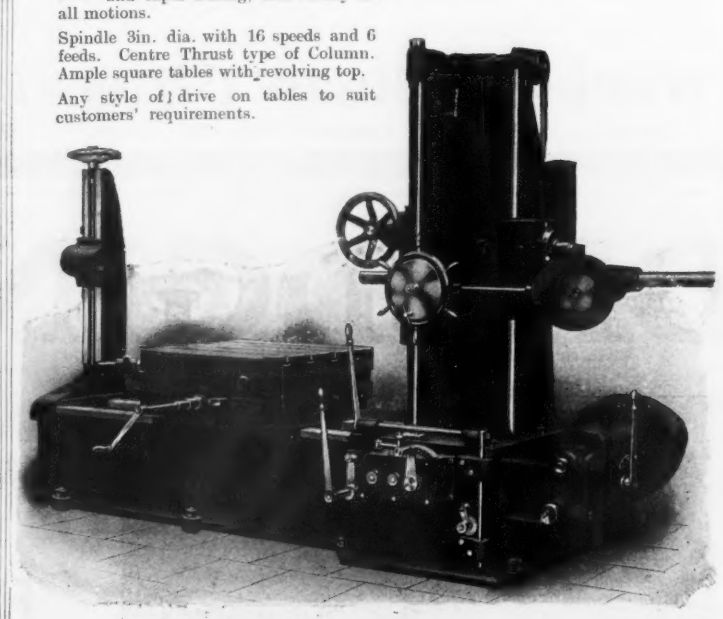

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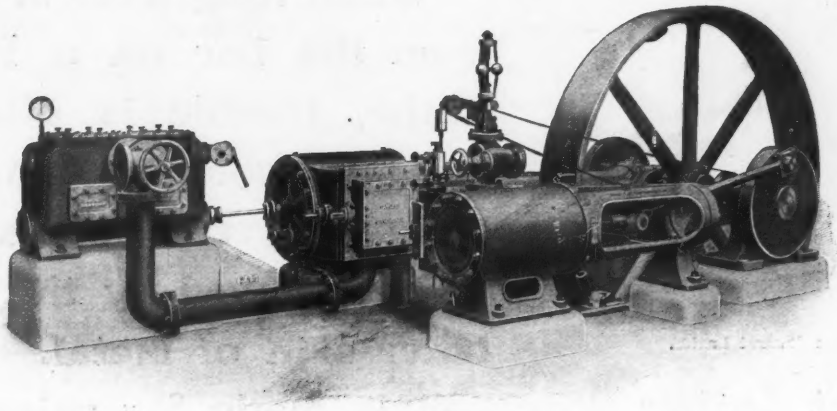

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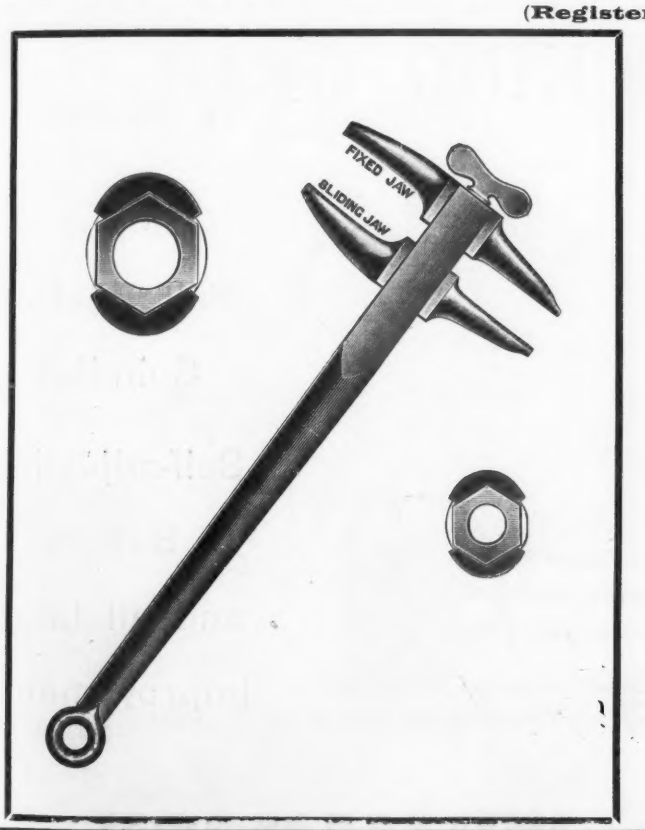

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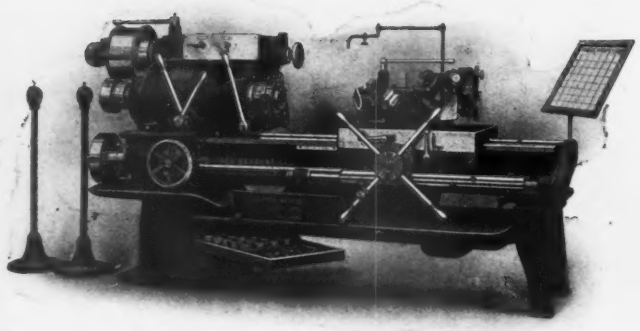

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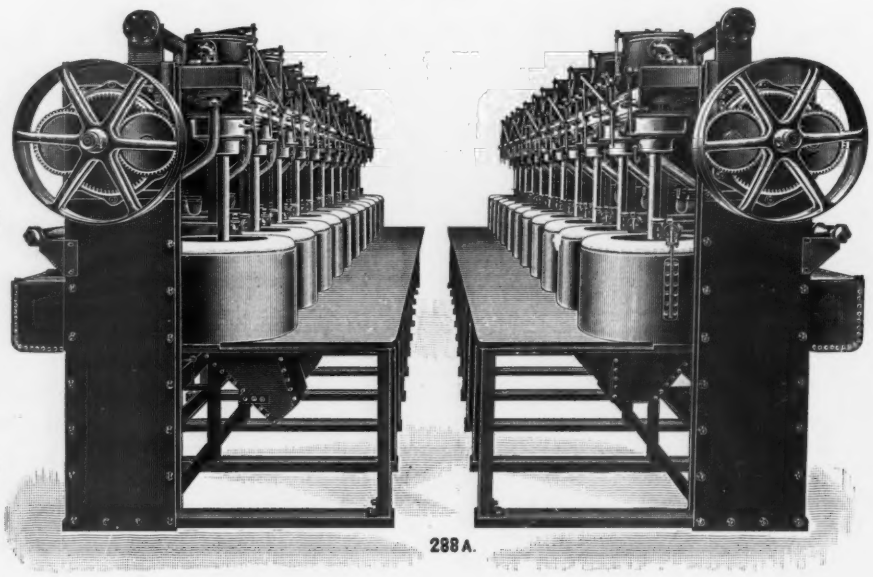

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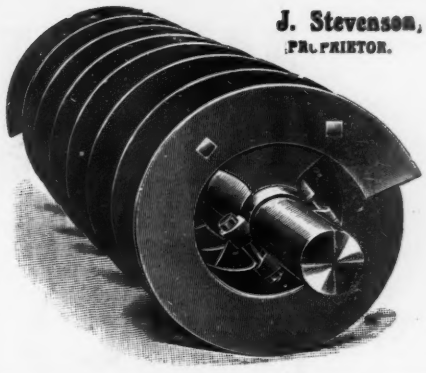

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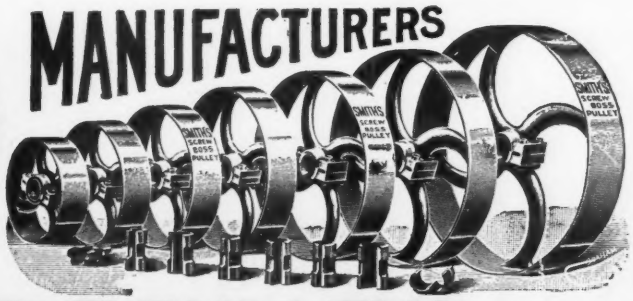

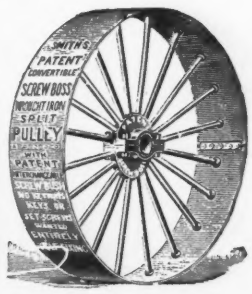

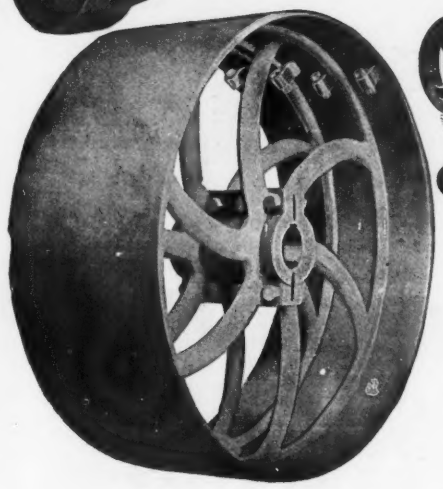

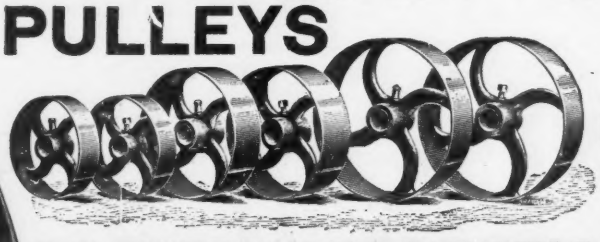

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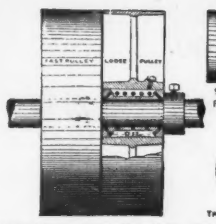

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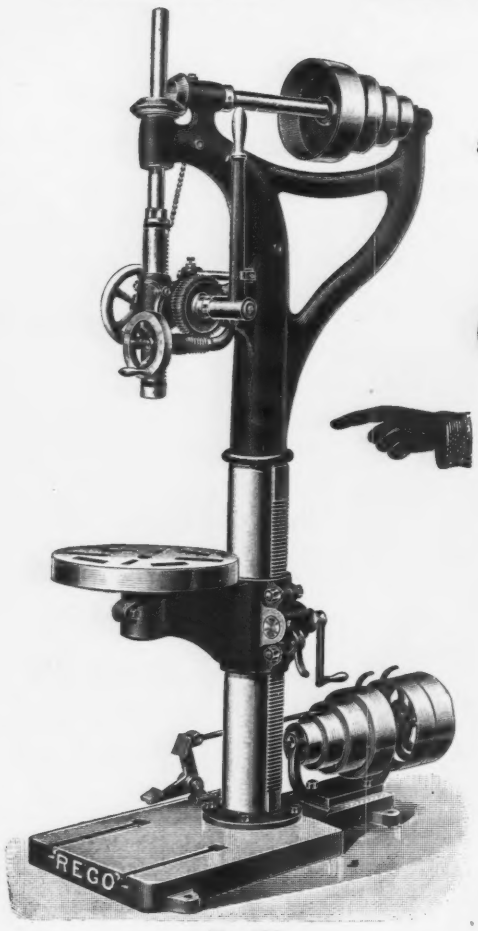

Fig. 150.

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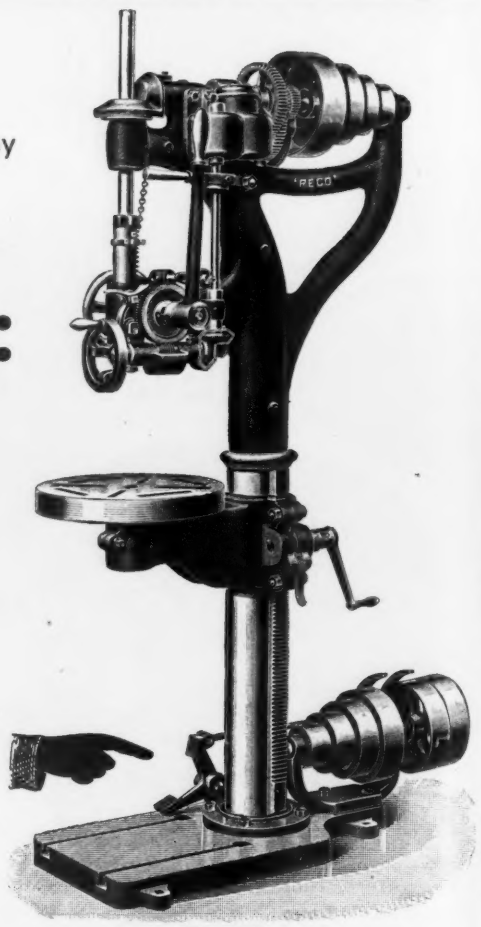

Fig. 152.

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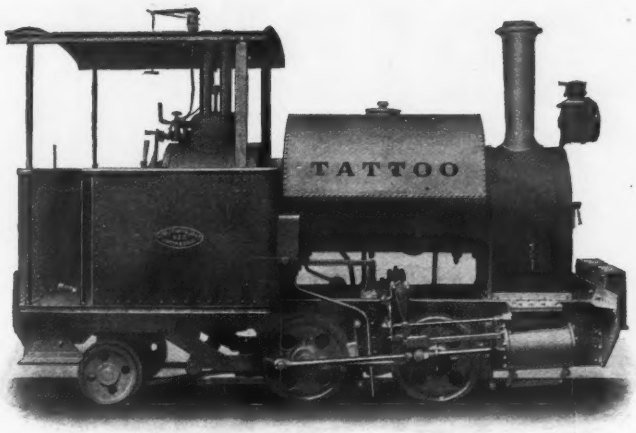

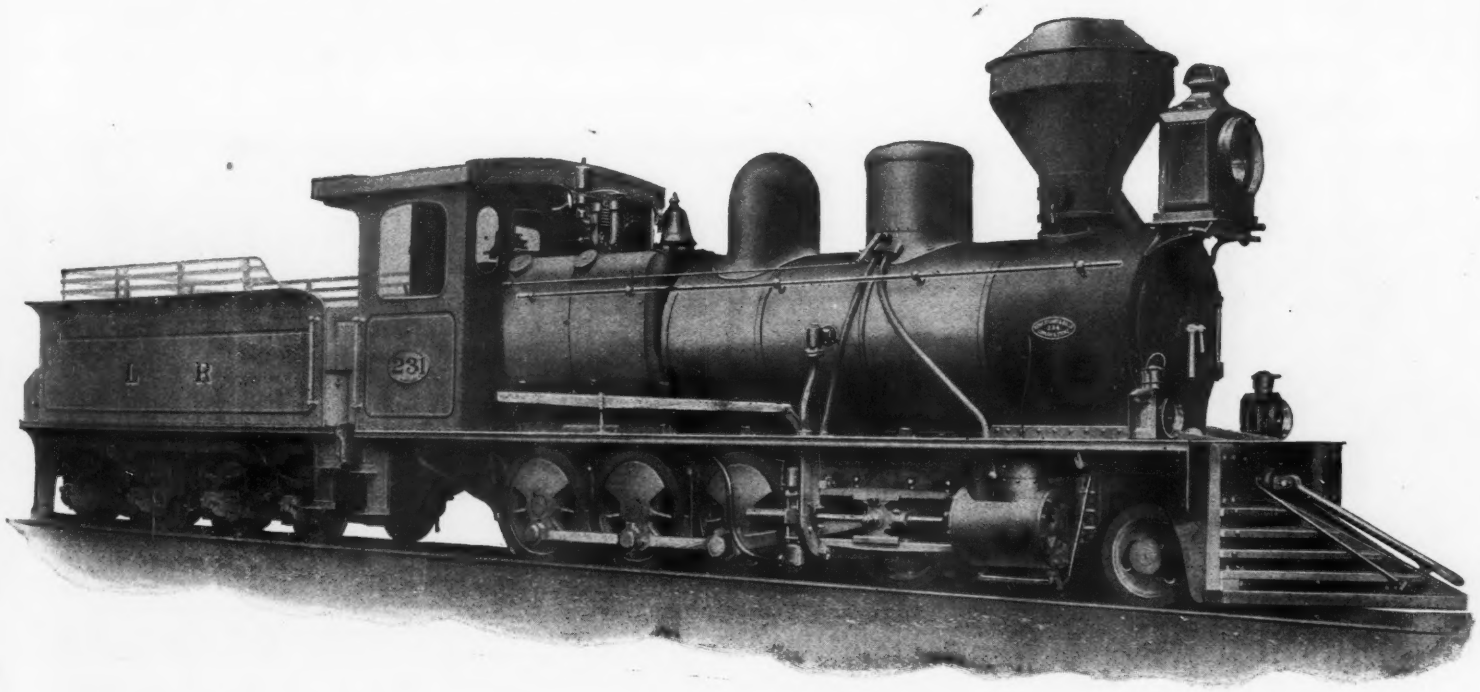

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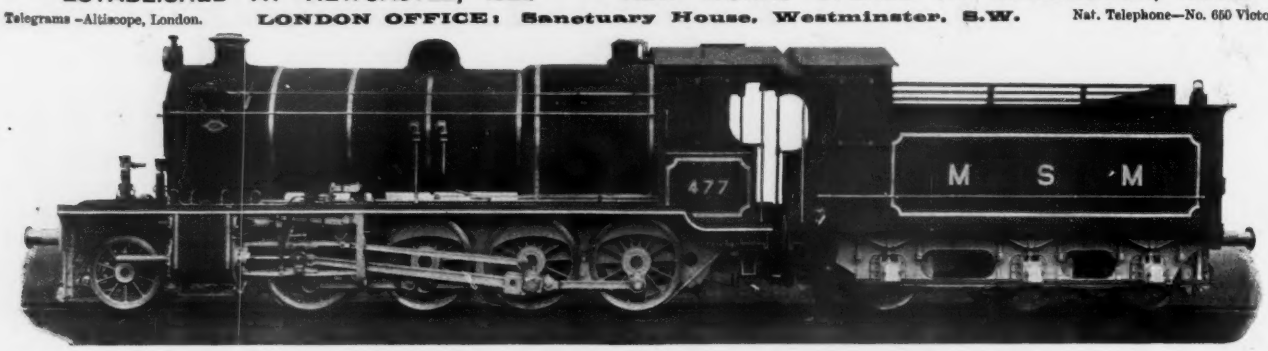

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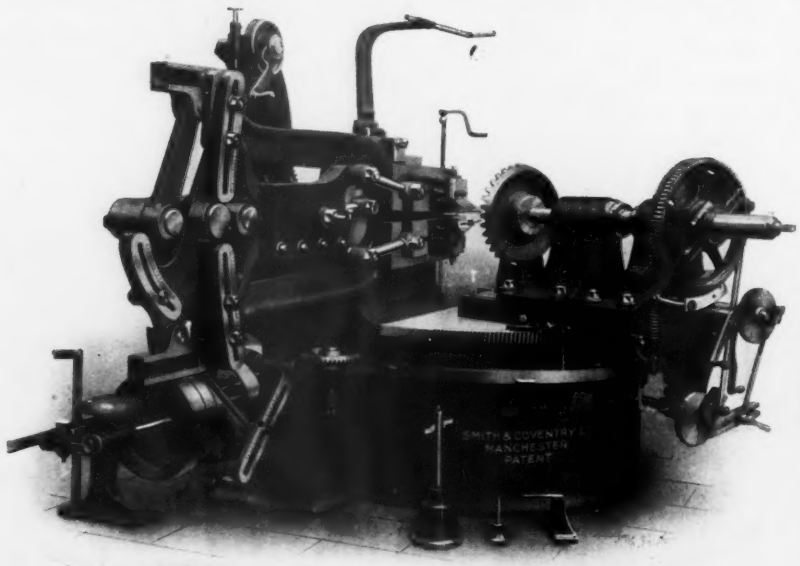

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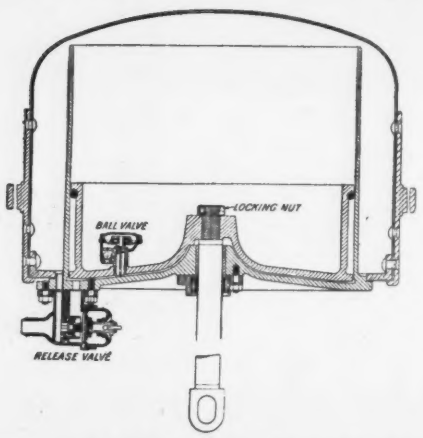

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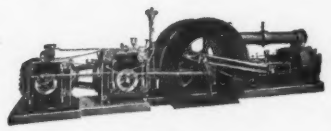

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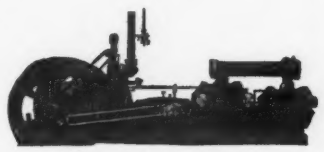

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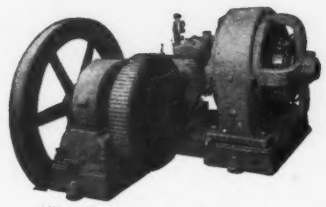

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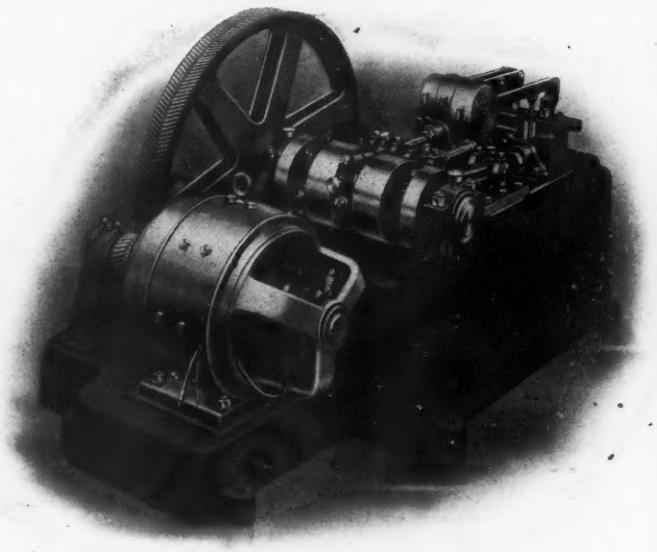

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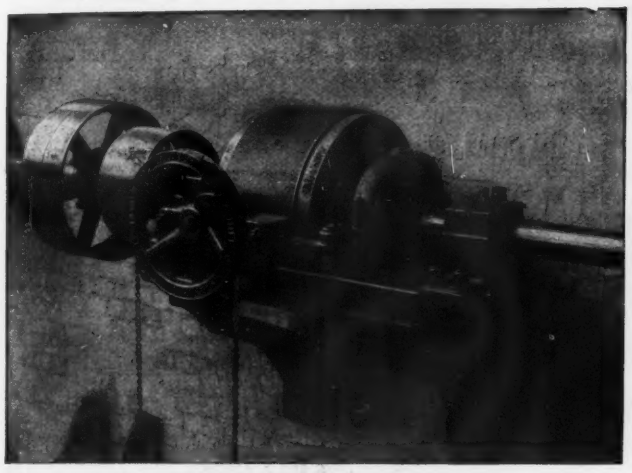

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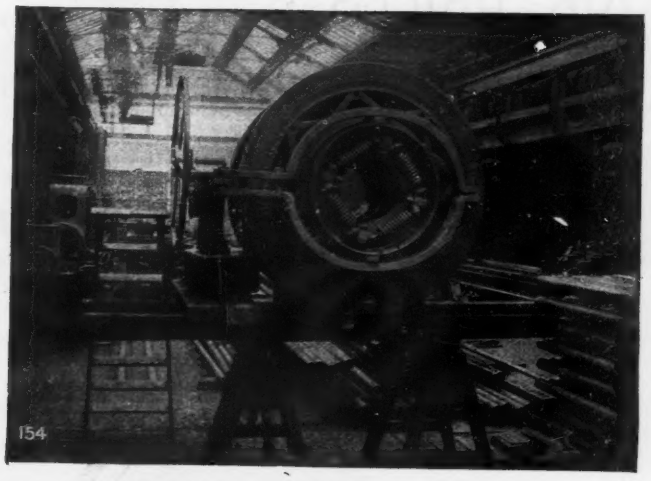

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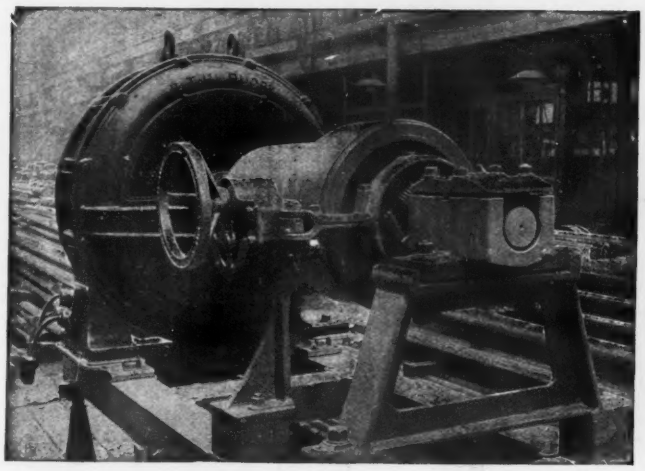

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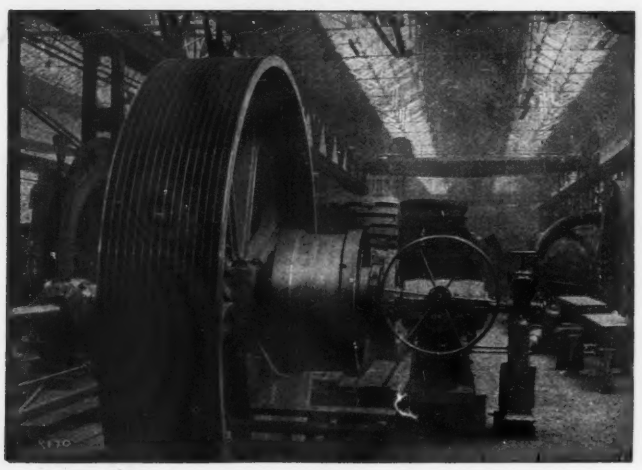

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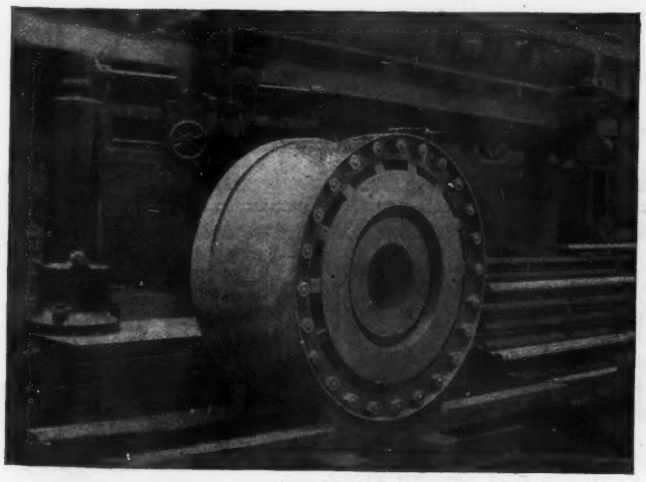

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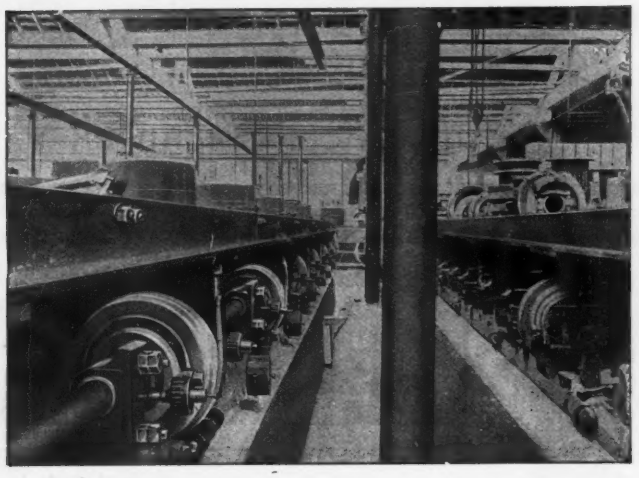

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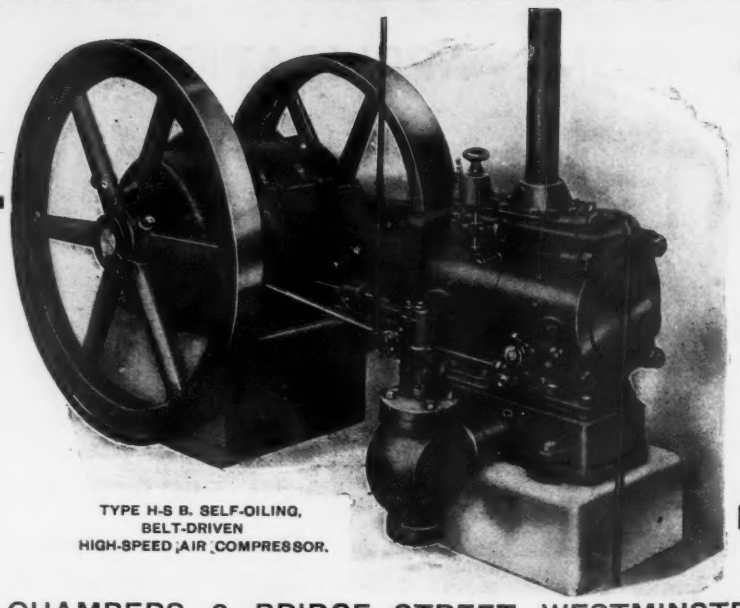

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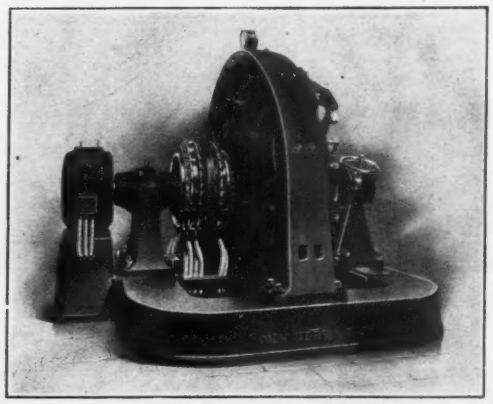

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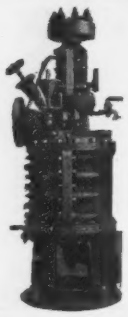

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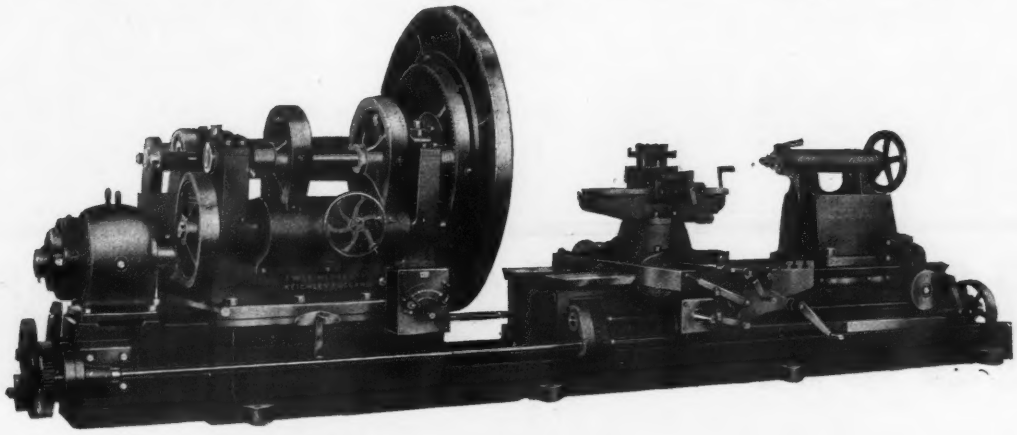

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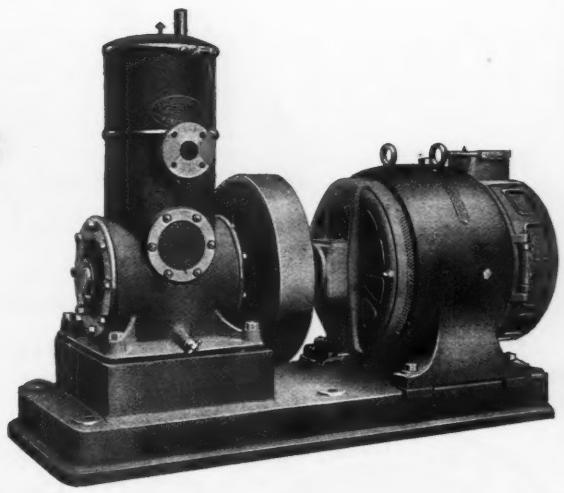

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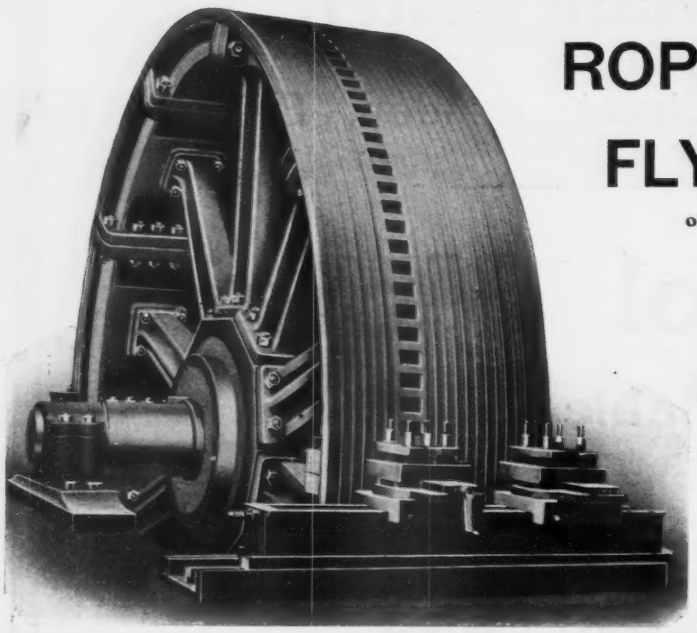

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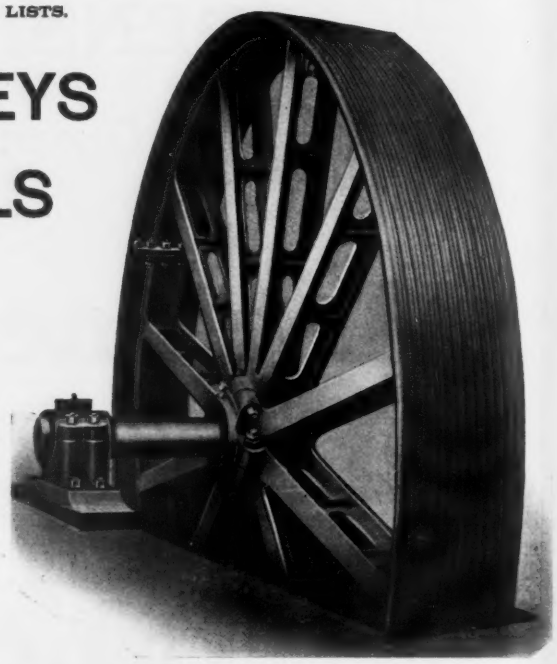

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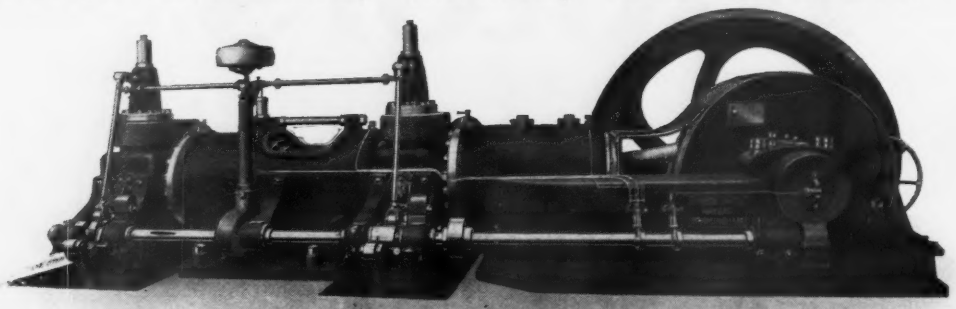

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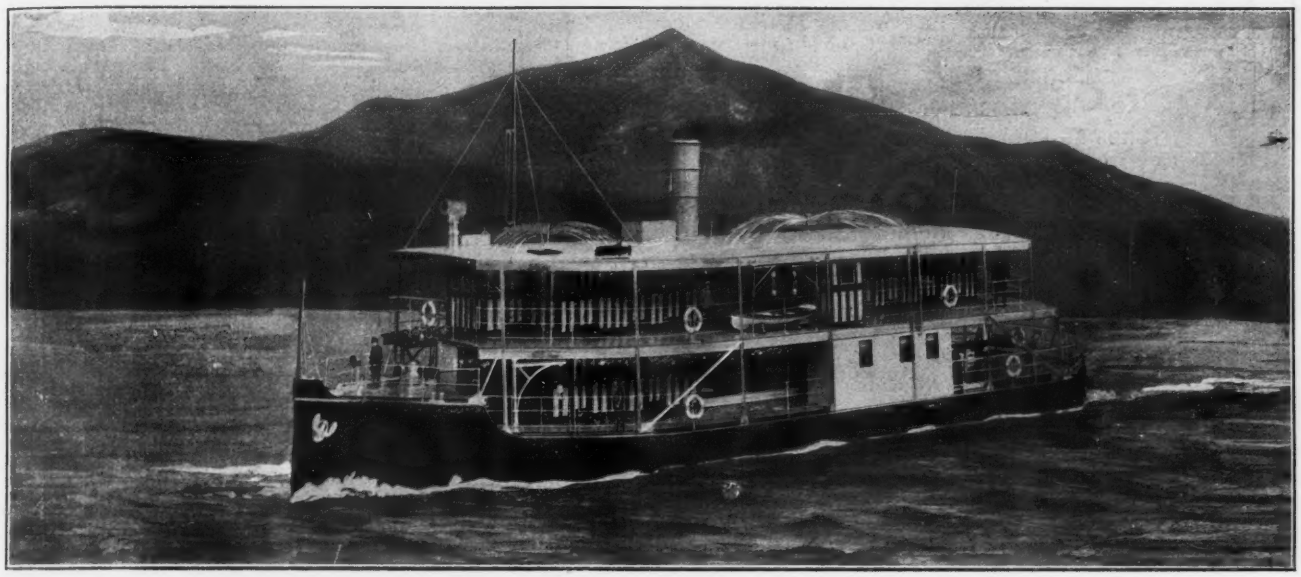

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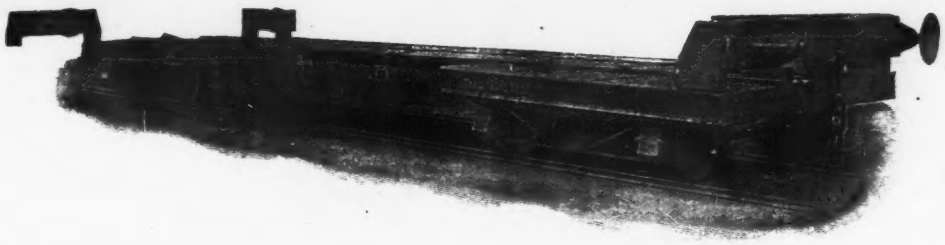

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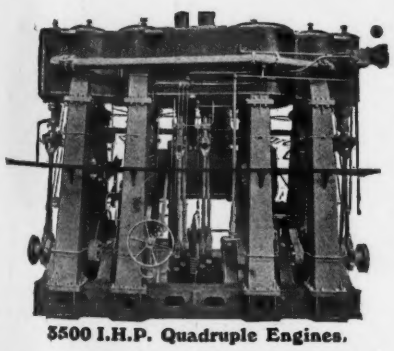

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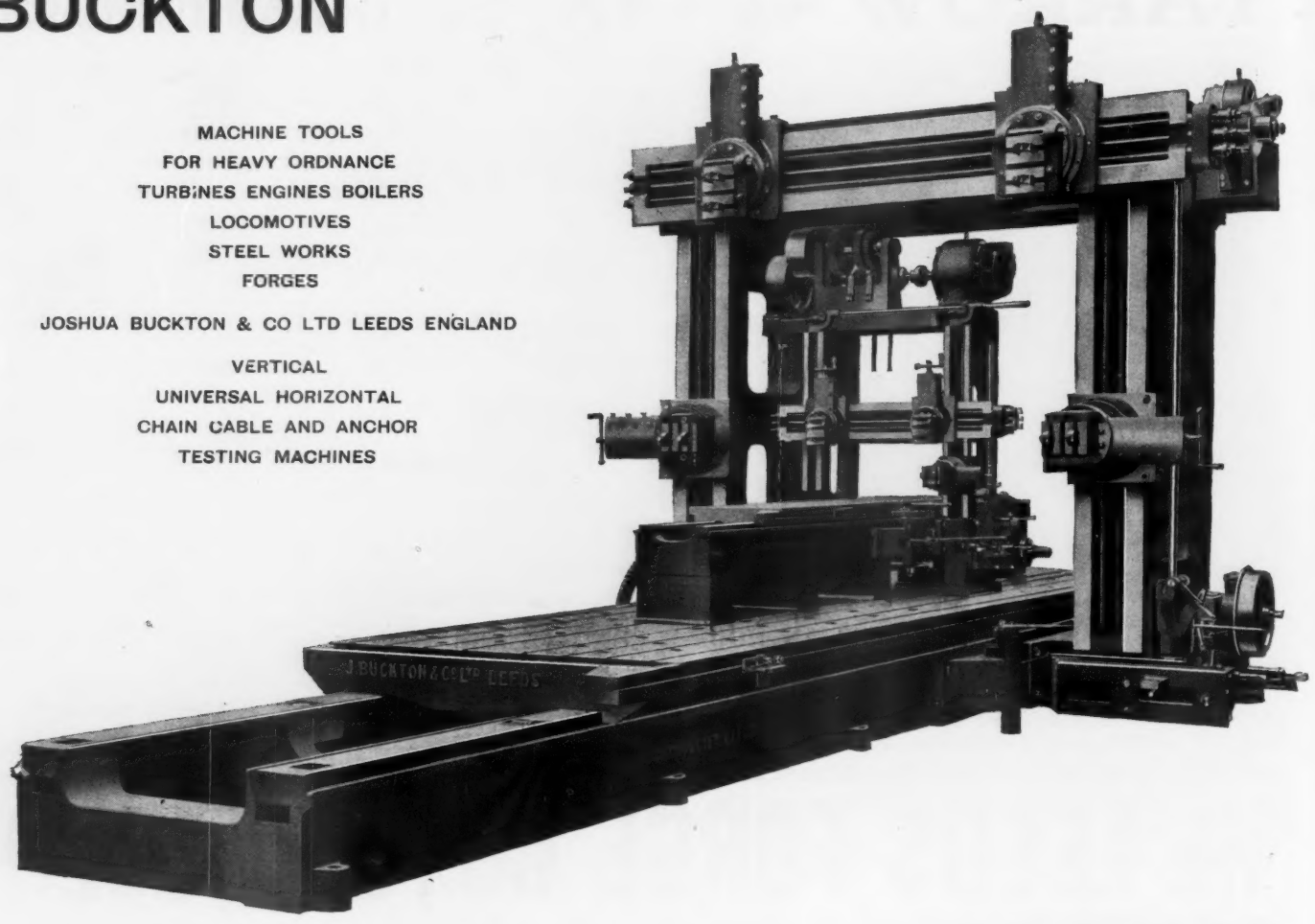

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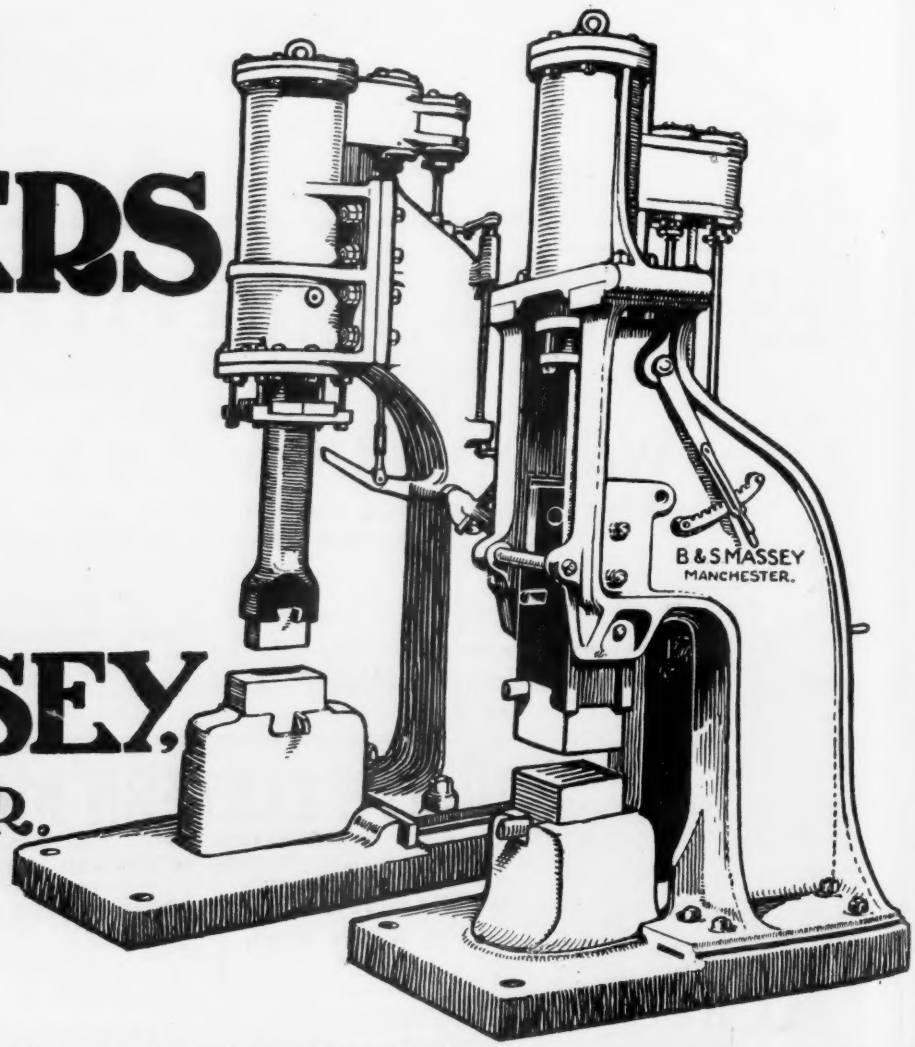

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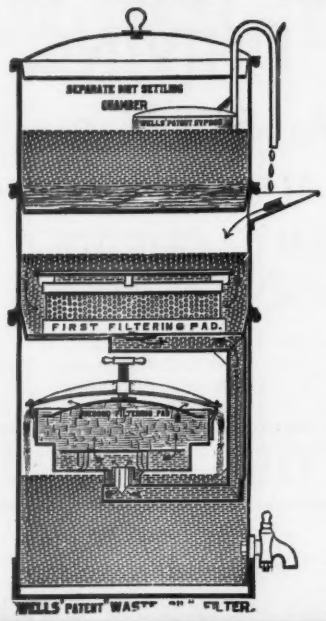

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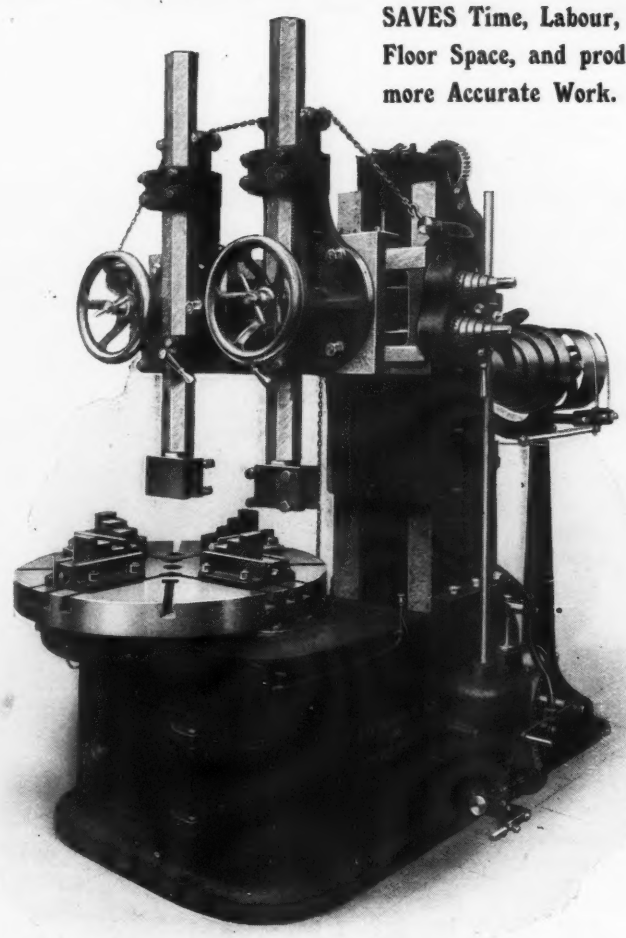

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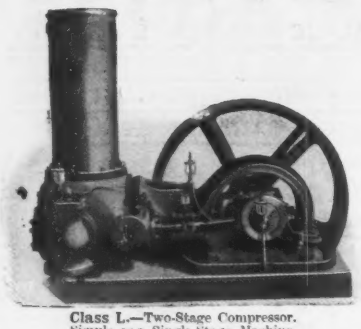

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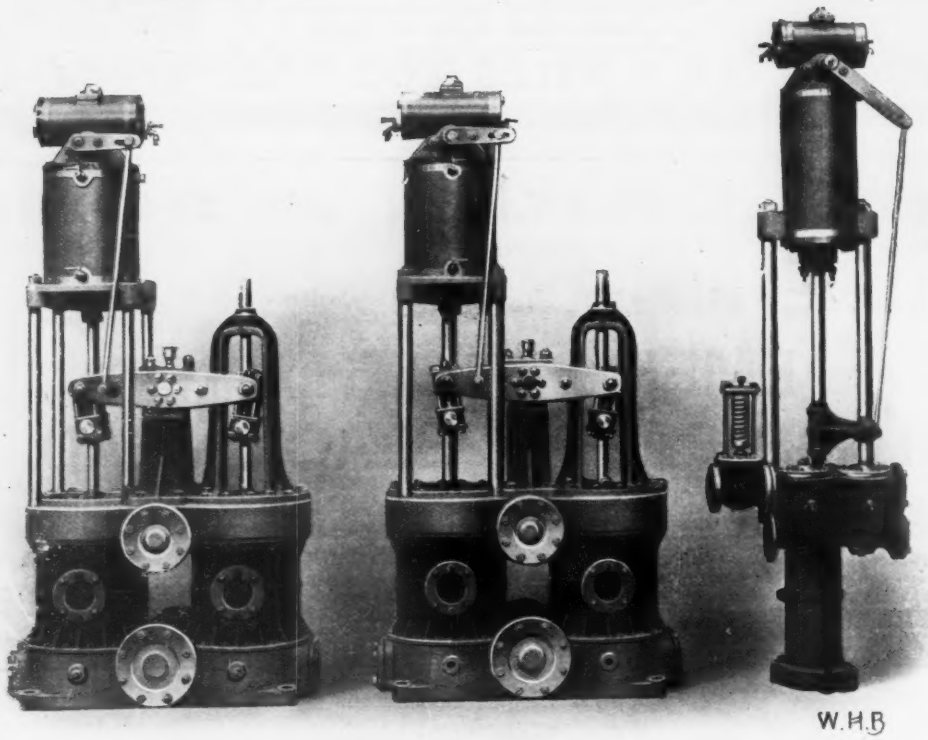

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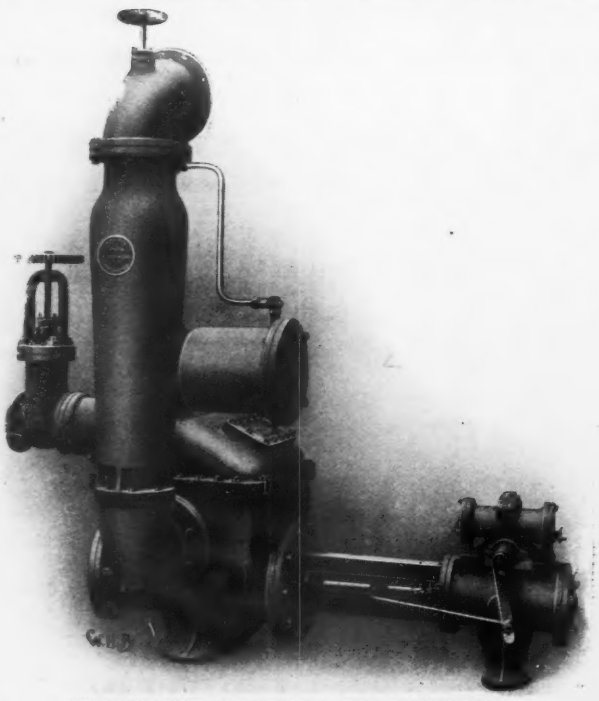

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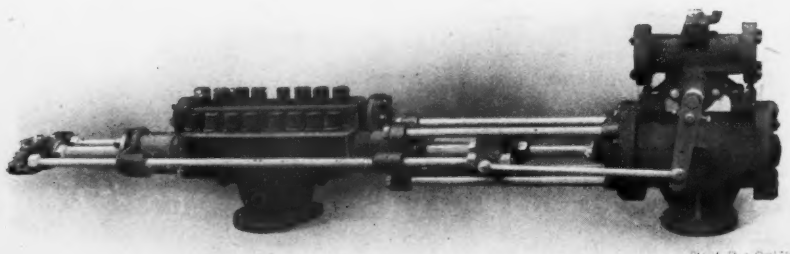

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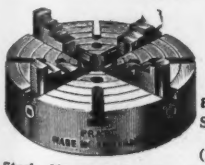
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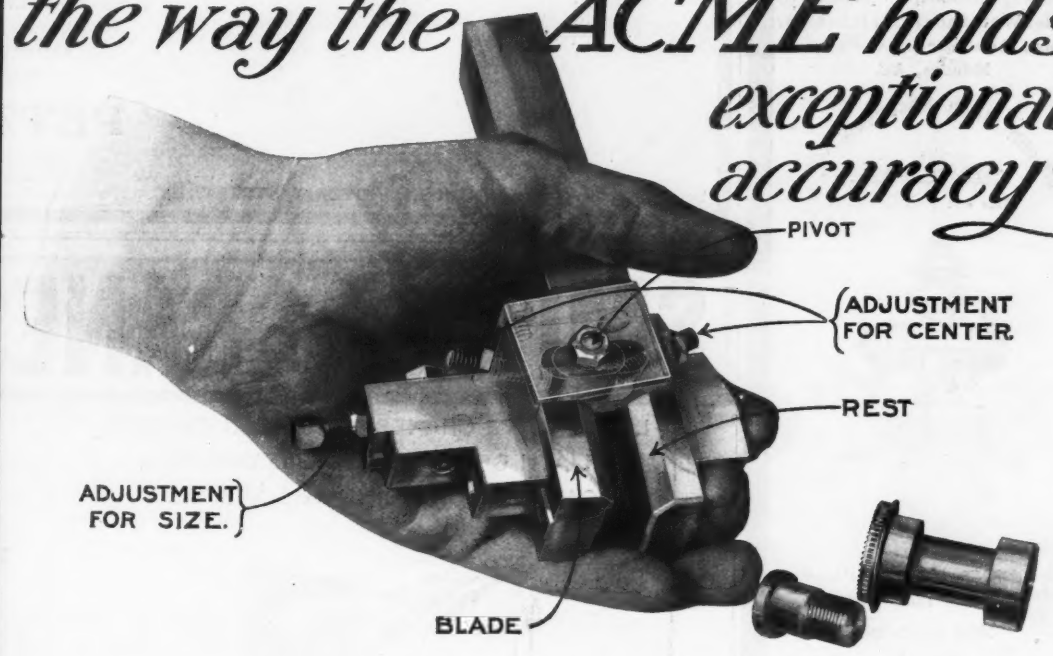

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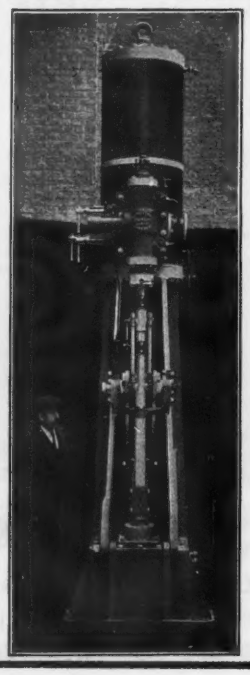
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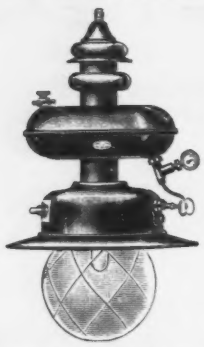

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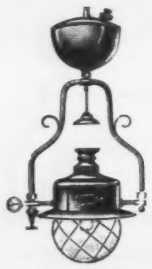

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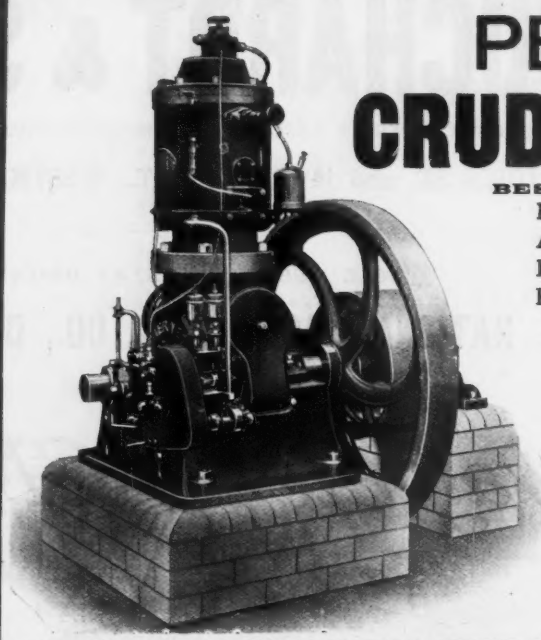

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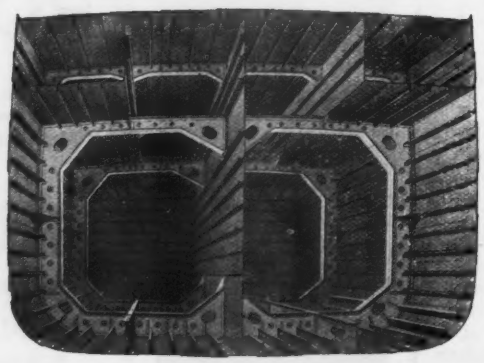

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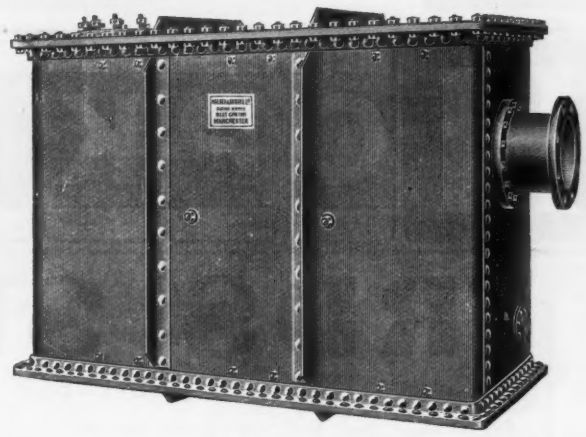

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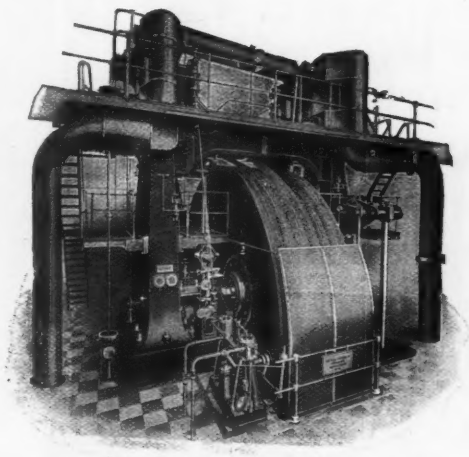

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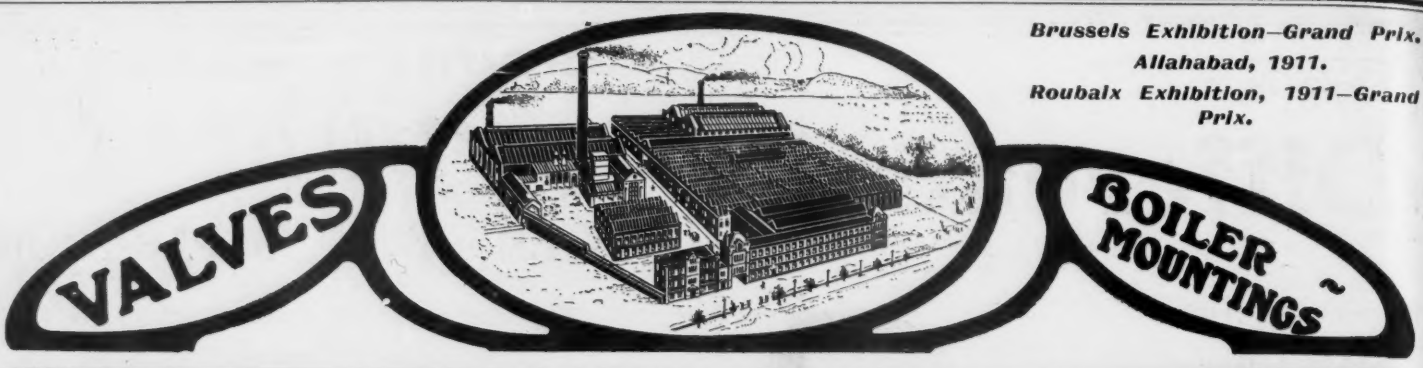

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The valve remains on its seat until the float has sunk low enough to touch the collar on valve; it then immediately begins to discharge.

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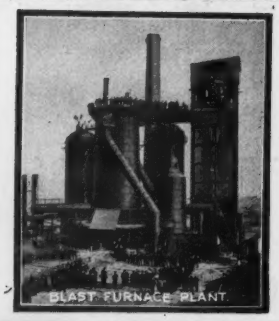
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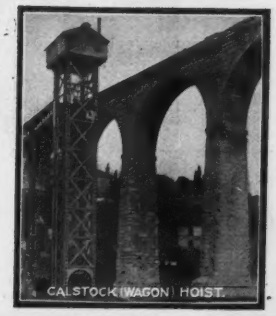
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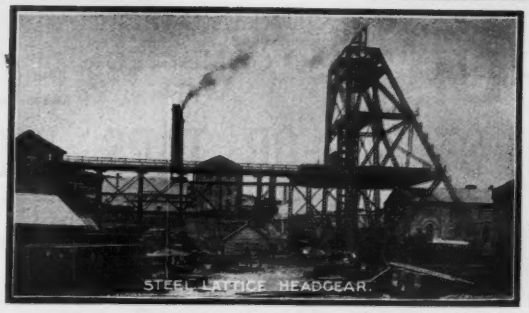
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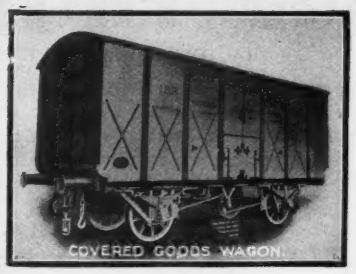
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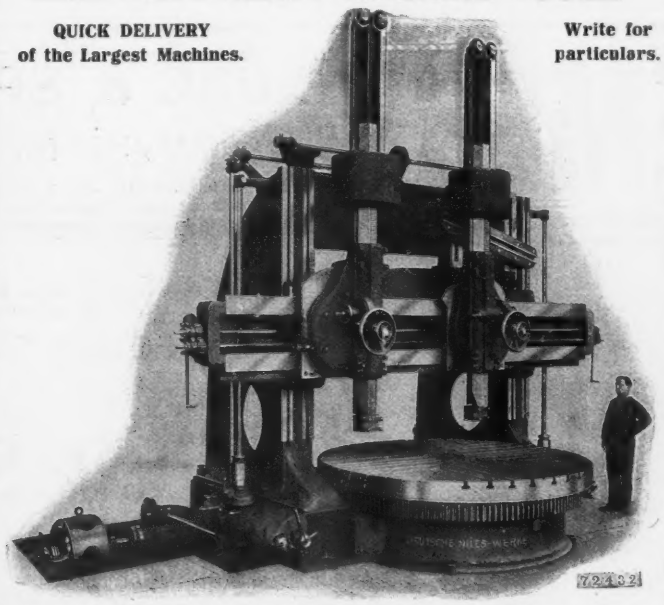

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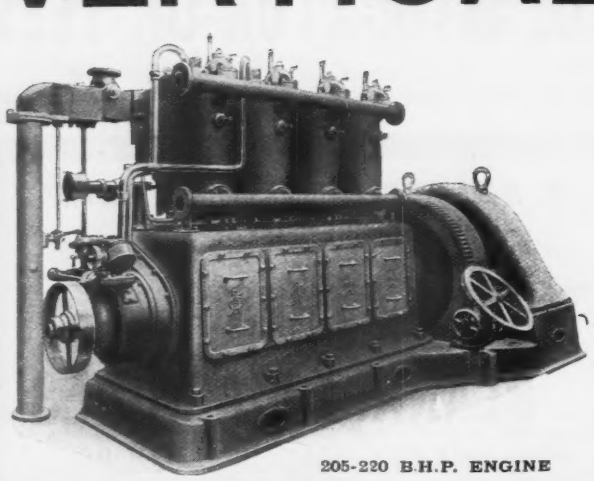

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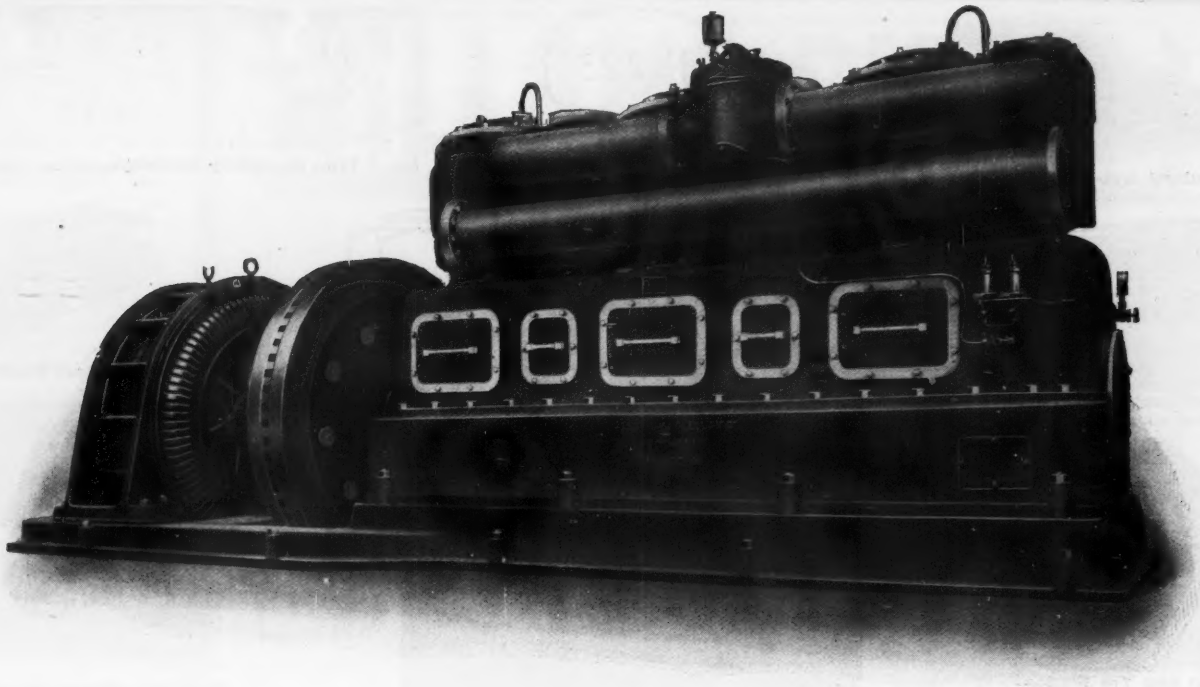

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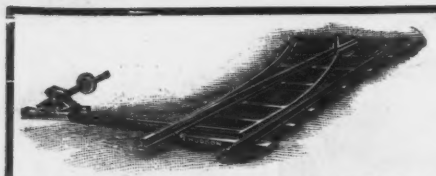
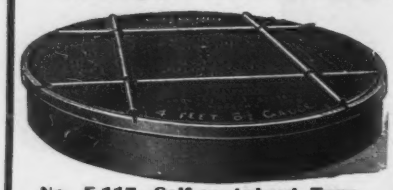


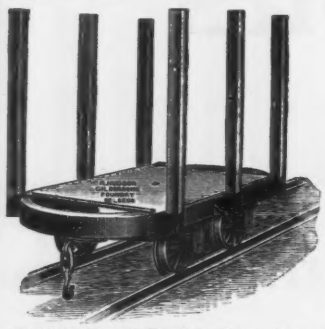
No. E 396—Standard left-hand Switches & Crossings, with Switch Box and Lever.



No. E 117—Self-contained Turntables, all sizes.

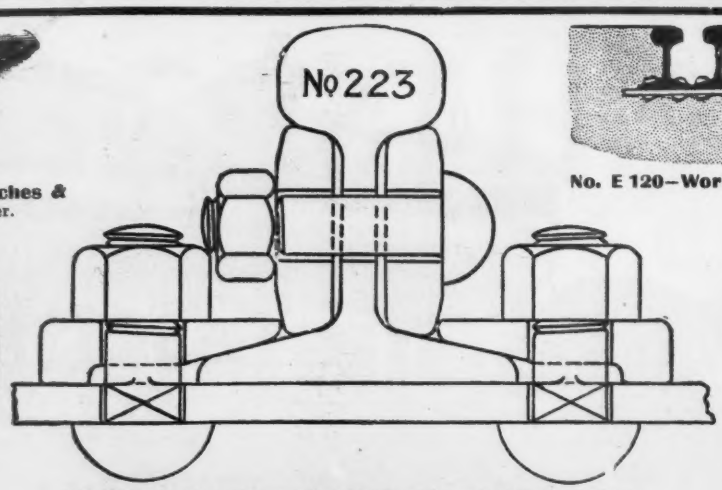
No. E 1—Steel End Tip Wagon.

No. E 410—Patent Side Tip Wagon with Hinged Lids. For conveyance of night soil, &c.



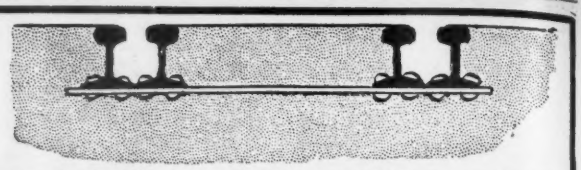
No. E 100—Steel Bogie with sockets and removable timber uprights for carrying brushwood, cane, &c.

No. E 442—Tip Buckets, with wheels for running on hard floors.

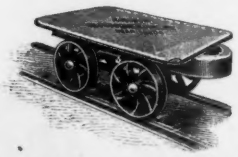


Steel Trough or Corrugated Sleeper, with Bolted Clips.

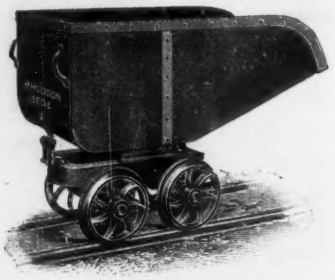
No. E 380—U-shaped Mining Truck.



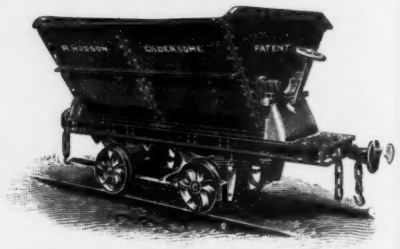
No. E 120—Workshop Railways, laid in Concrete or Asphalte.



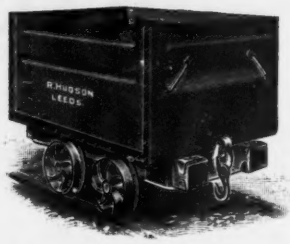
No. E 58—Steel Plate Bogie.



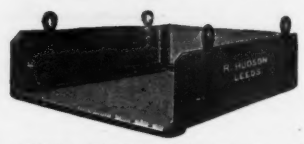
No. E 483—Scoop Type Mine Car, tips at sides and end.



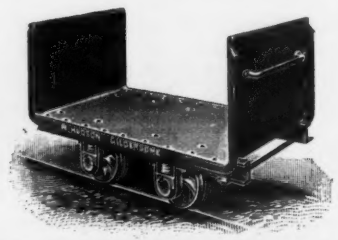
No. E 440—High Capacity Patent Side Tip Wagon, with Automatic Couplers and Screw Brake.



No. E 457—Patent Pressed Steel Colliery Tub, with well bottom.



No. E 454—Rubble Skips, for Quarries.



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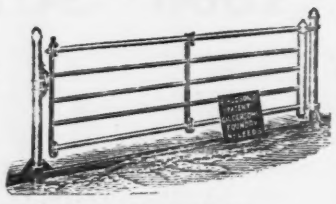

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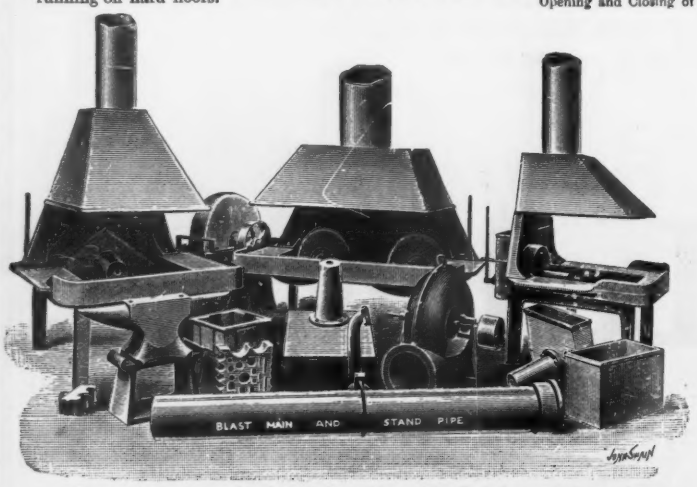
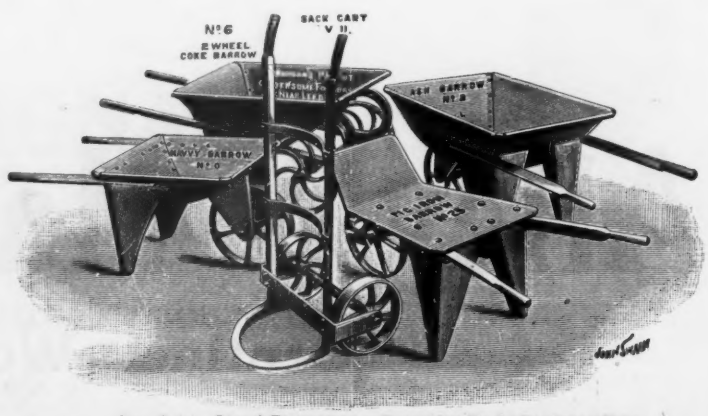


No. E 122—Iron Smiths' Hearths. No Brickwork Required.



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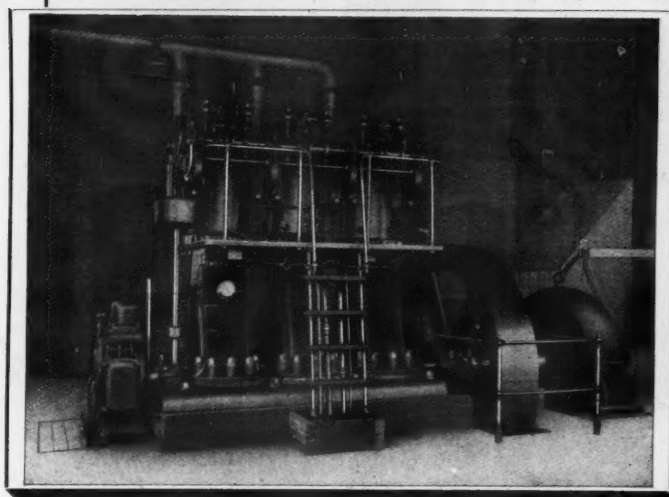

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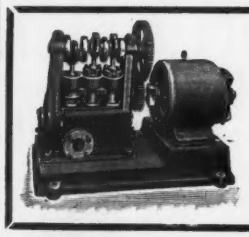

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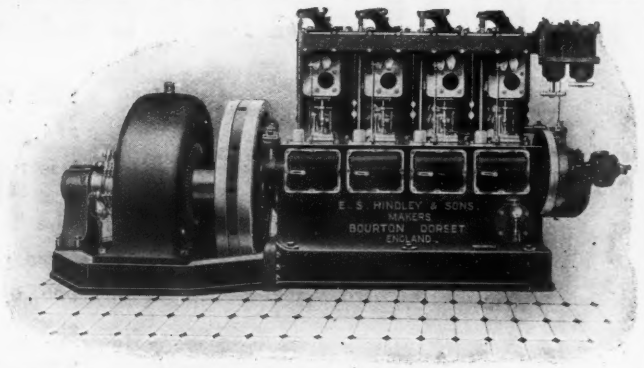

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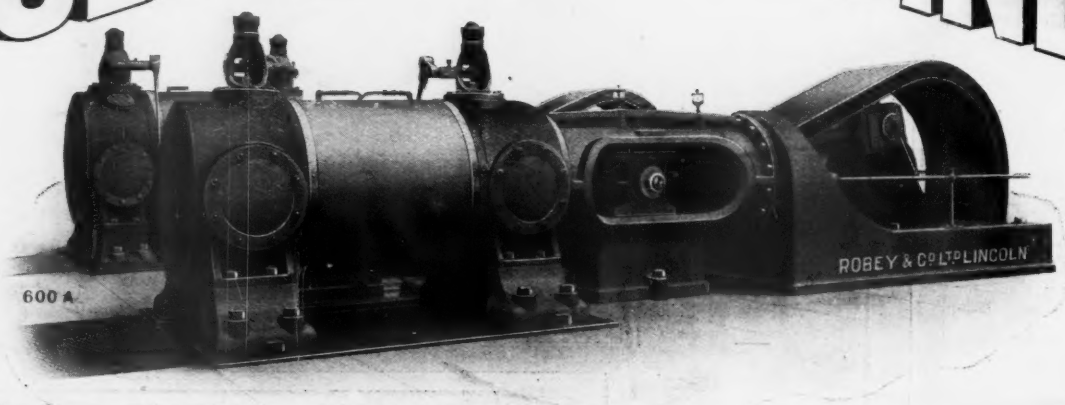

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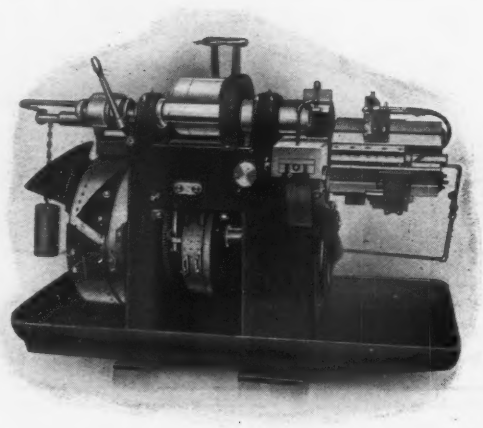

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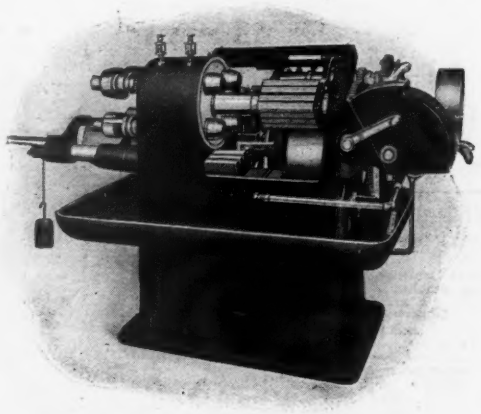

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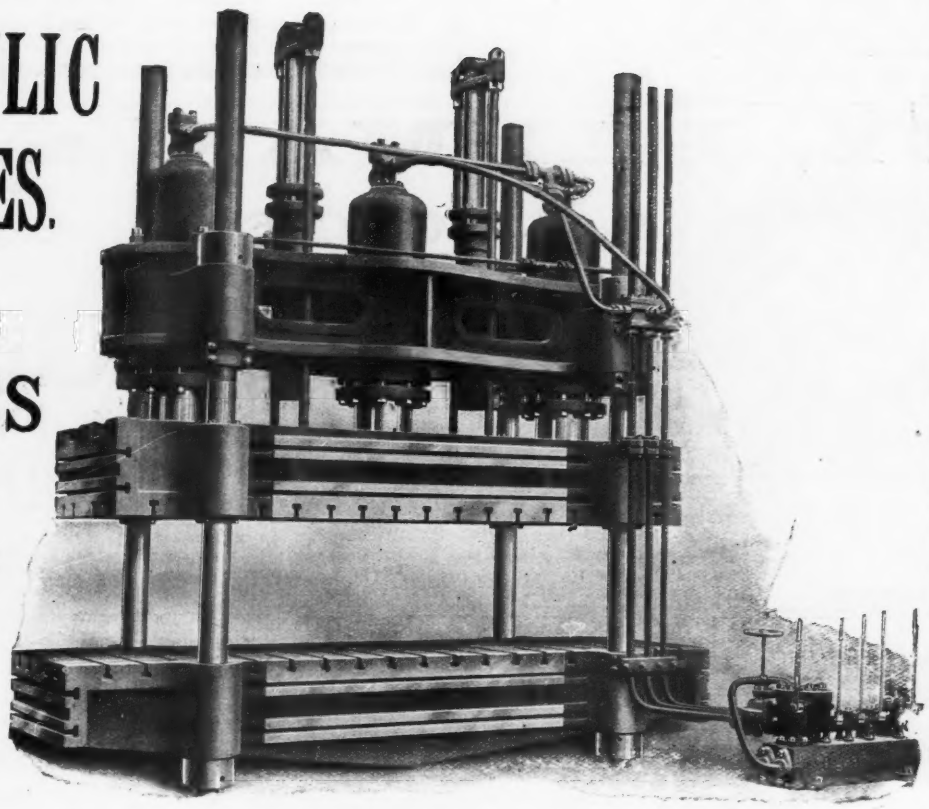

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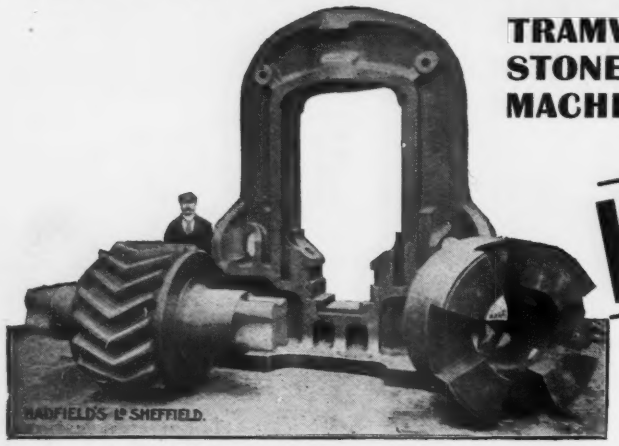

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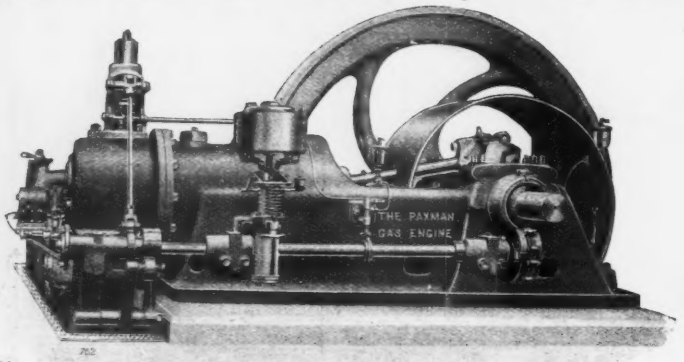

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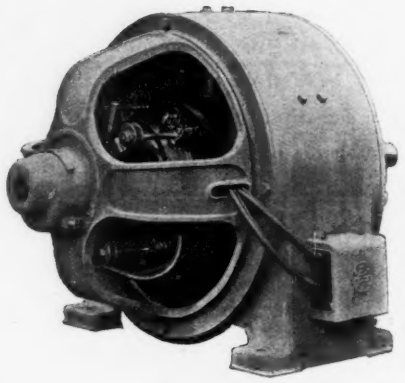

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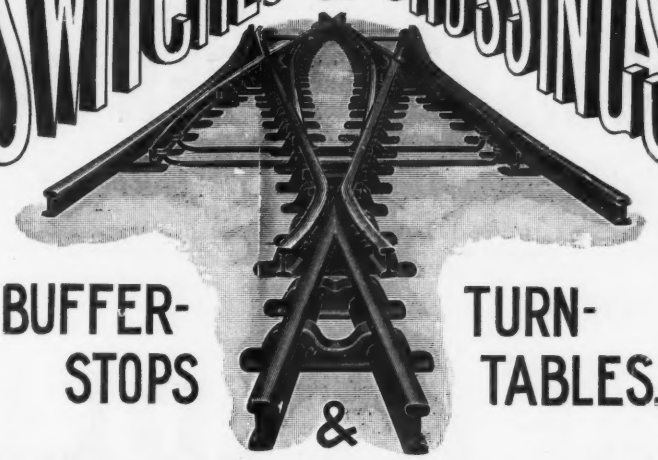
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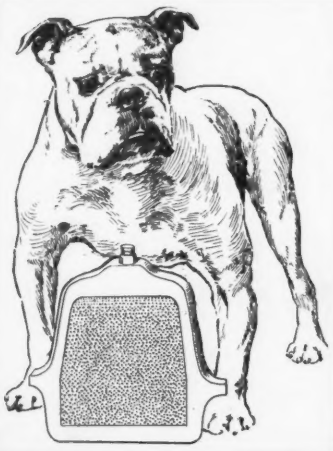

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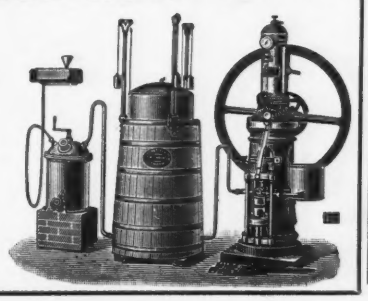

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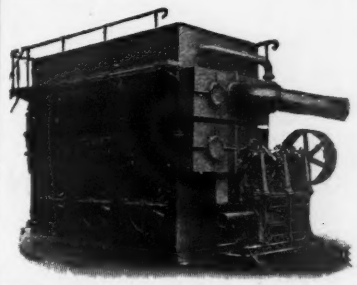
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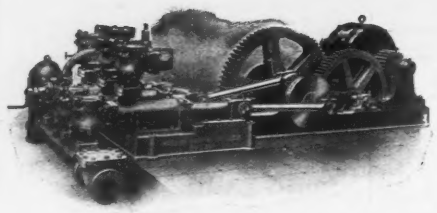

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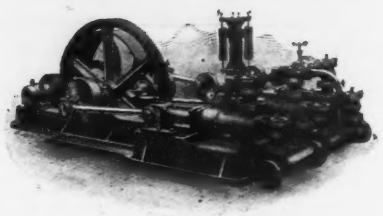

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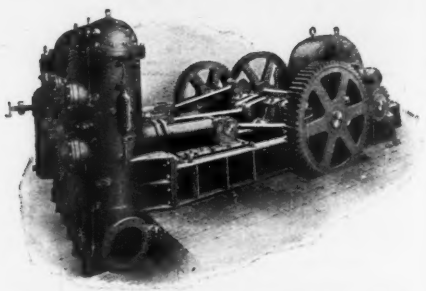

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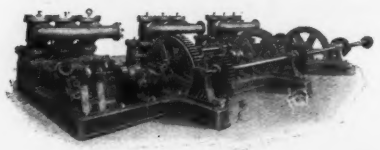

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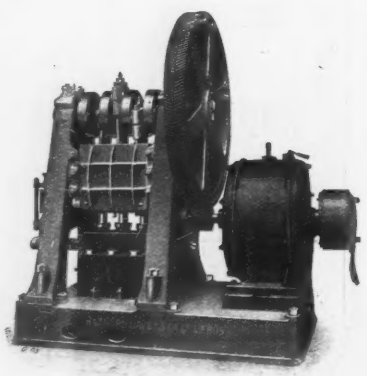

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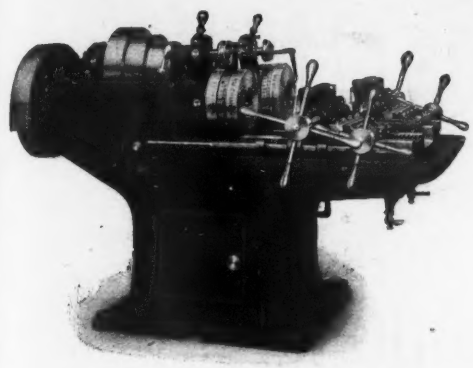

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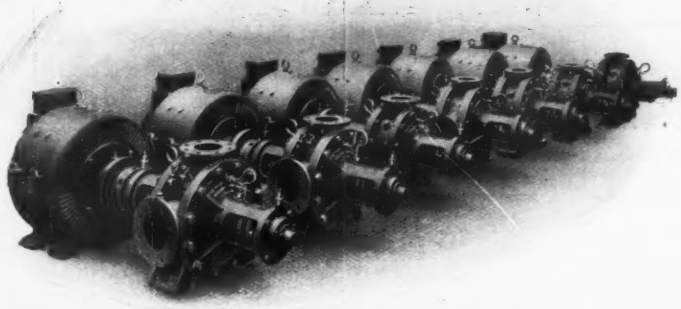

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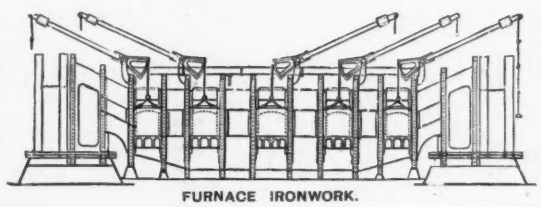

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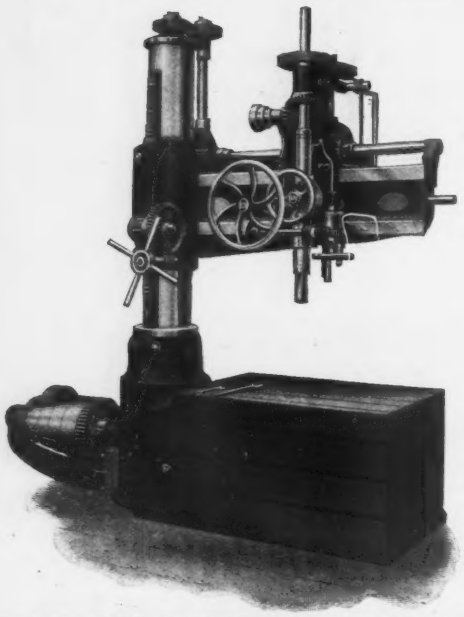

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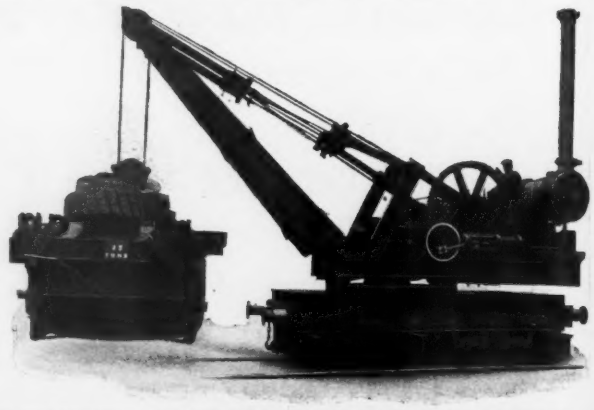

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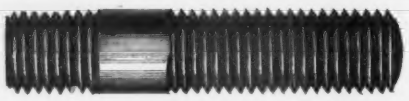

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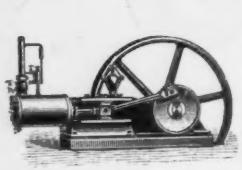

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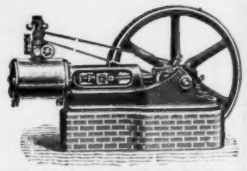

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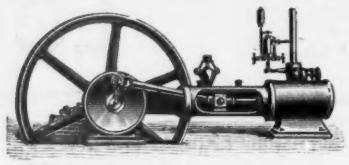

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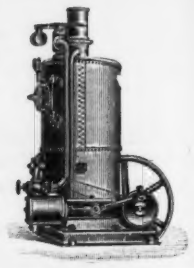

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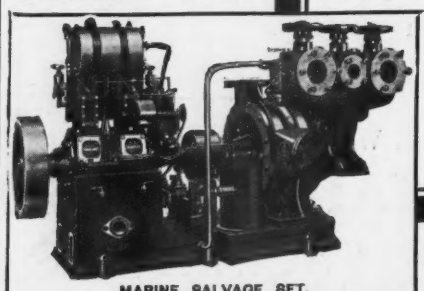

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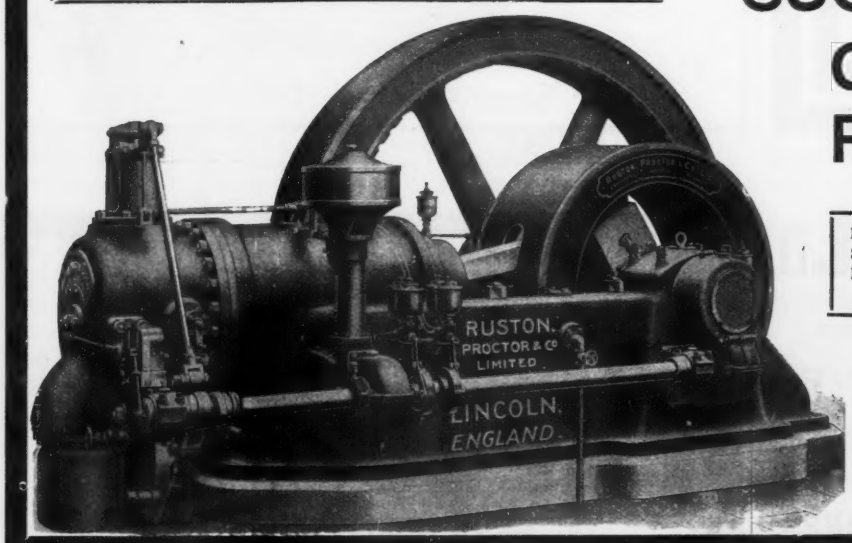

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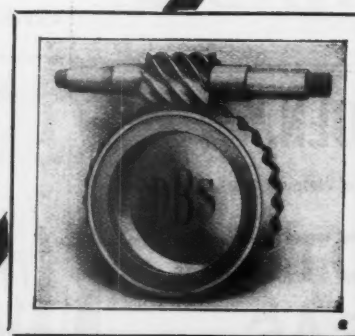

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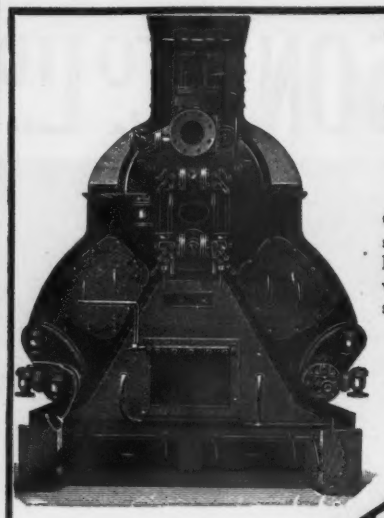

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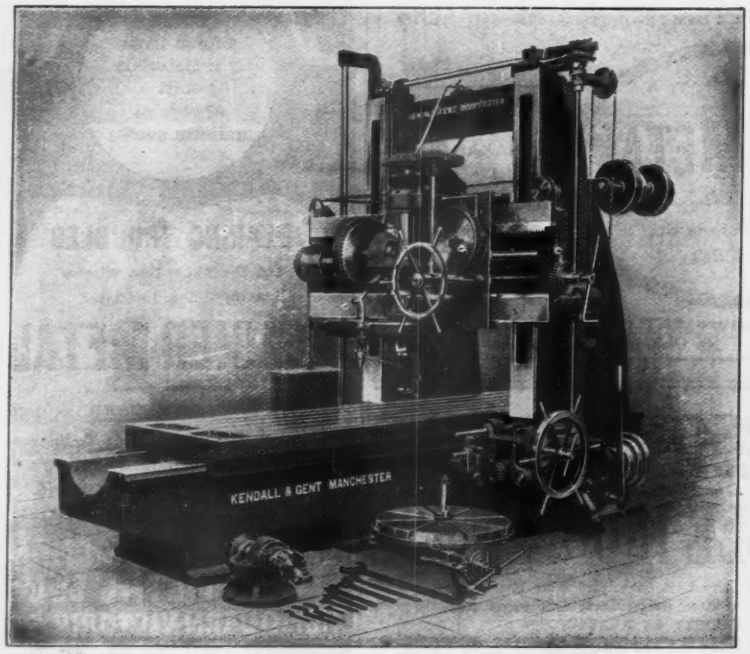

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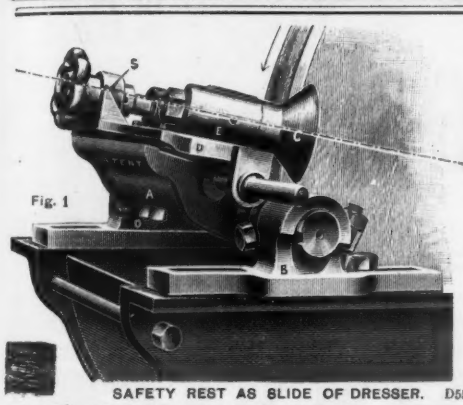

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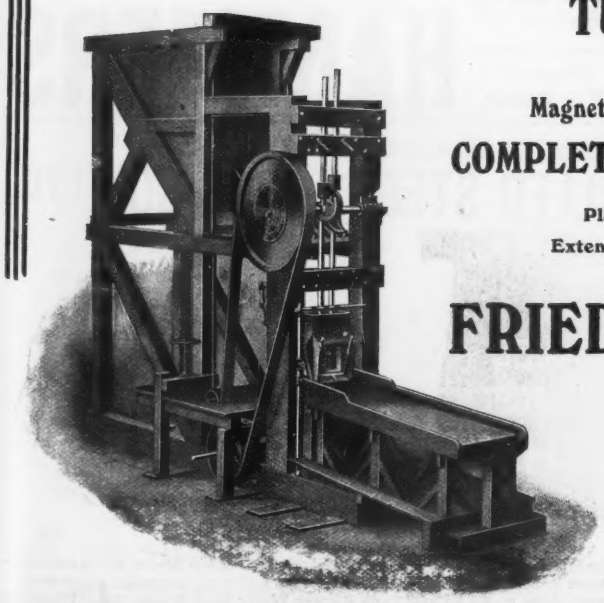

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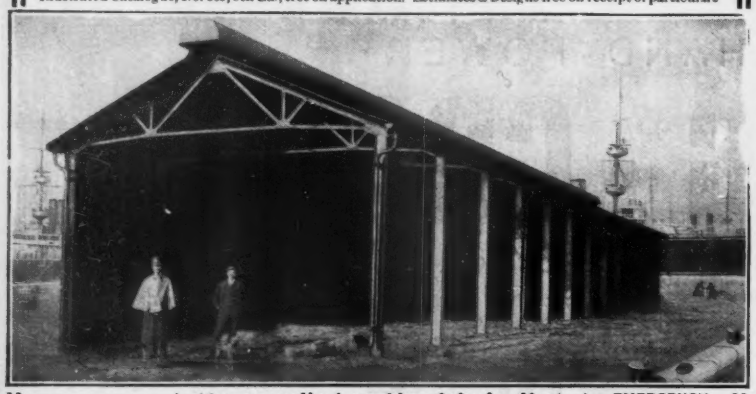

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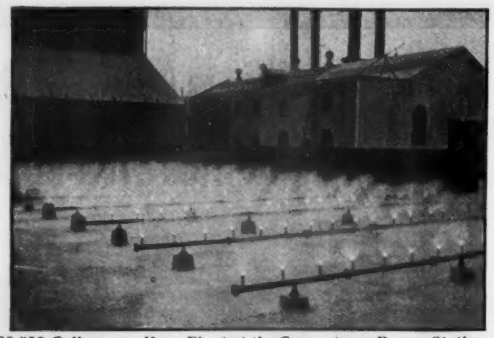

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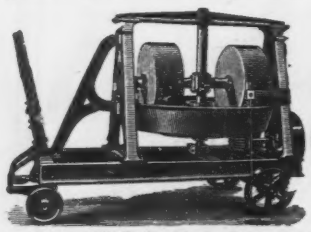

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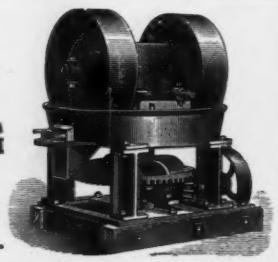

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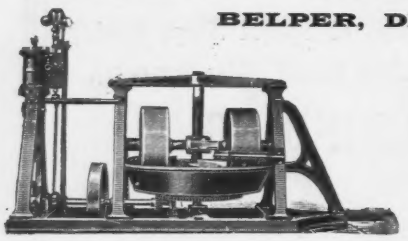

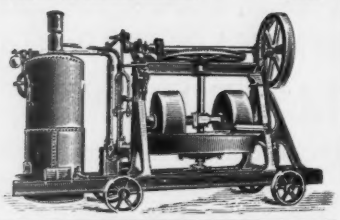

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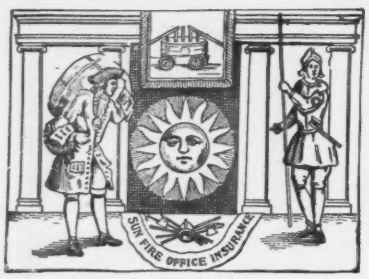

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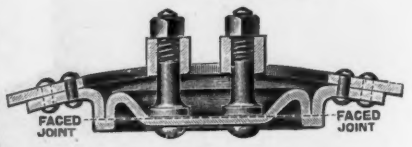

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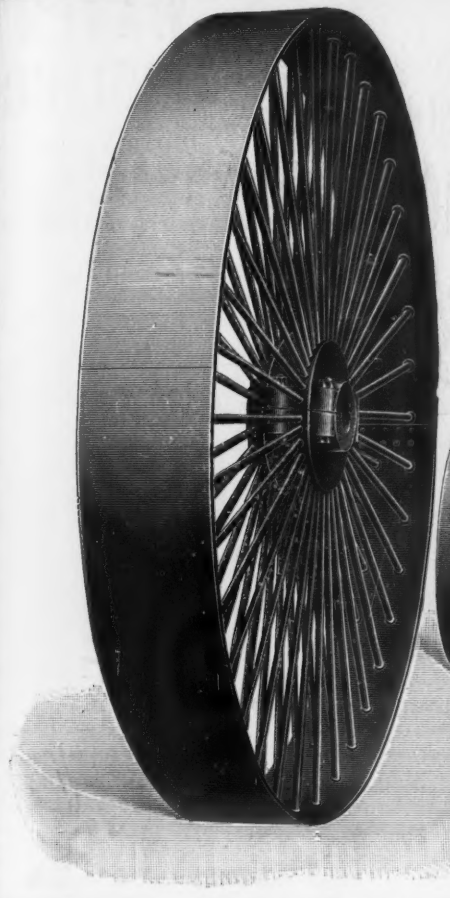

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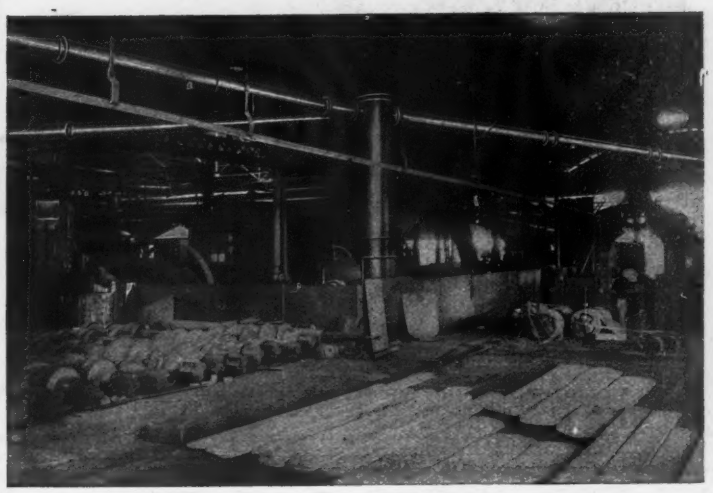

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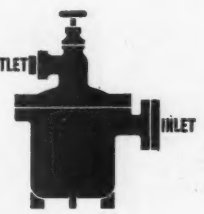

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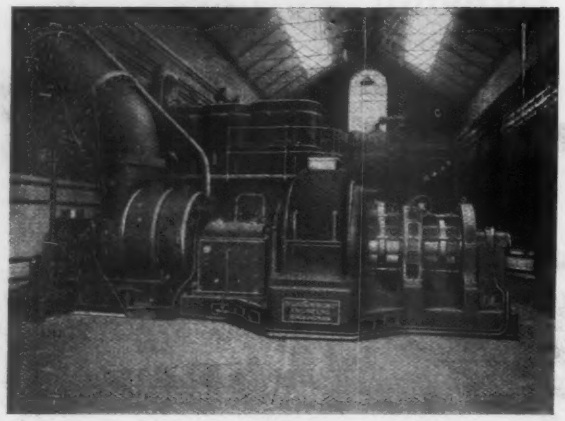

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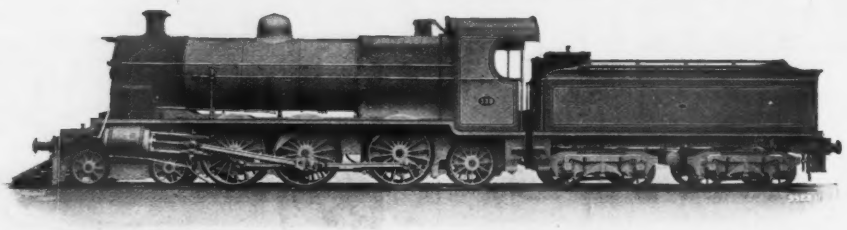

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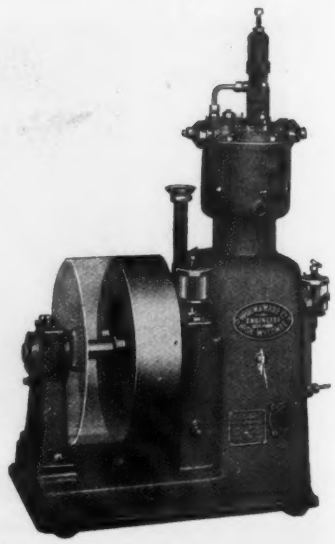

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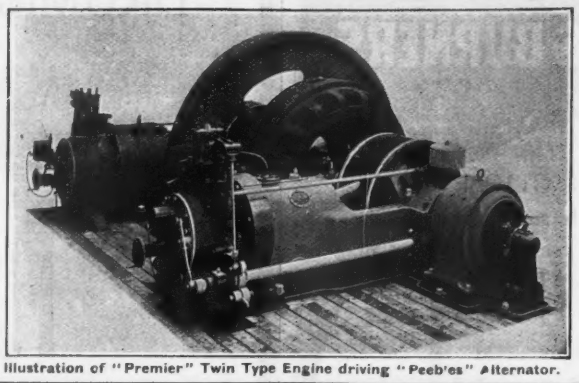

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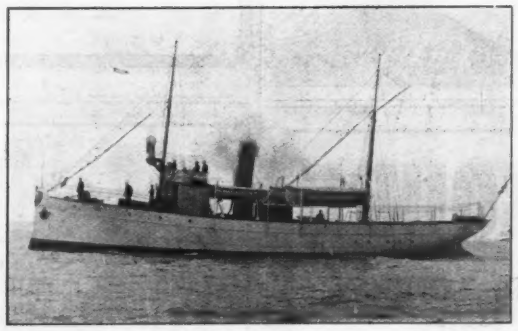

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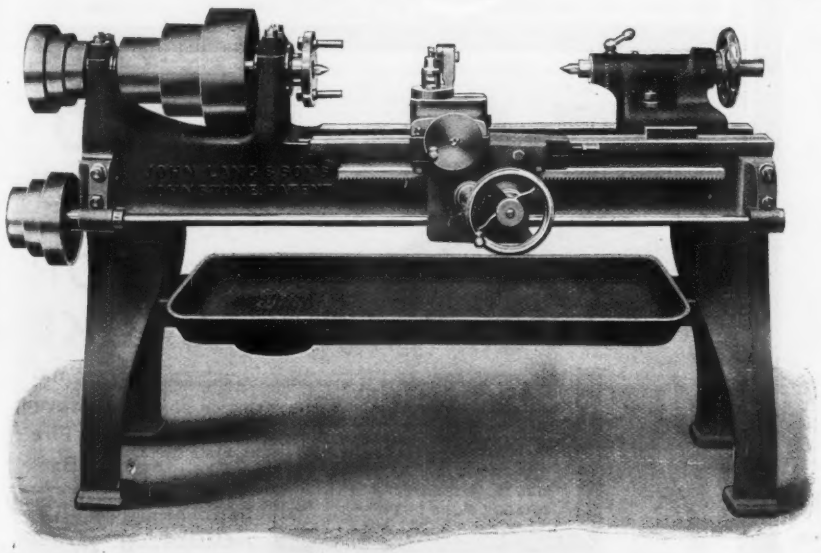

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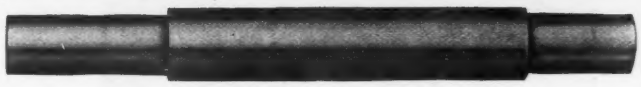

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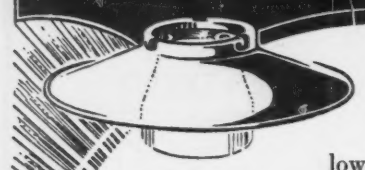

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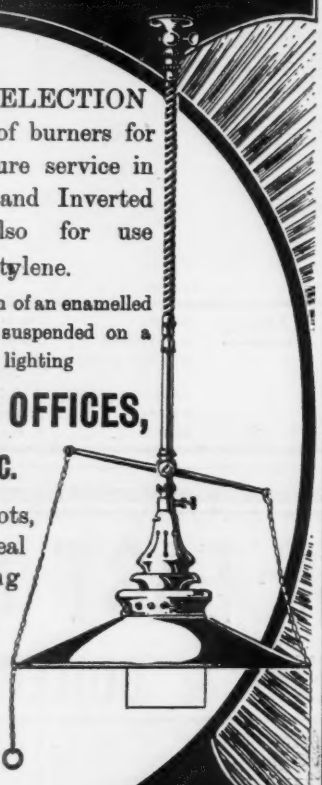

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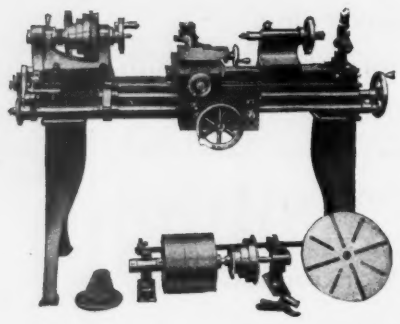

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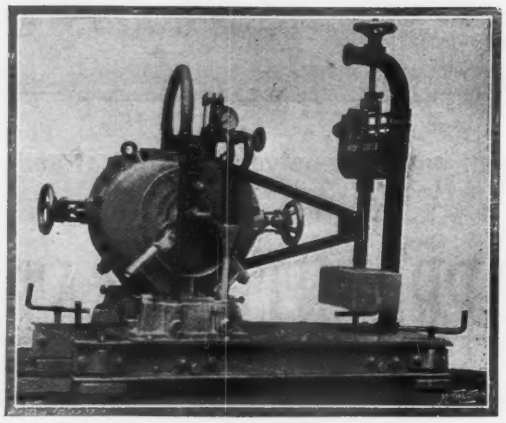

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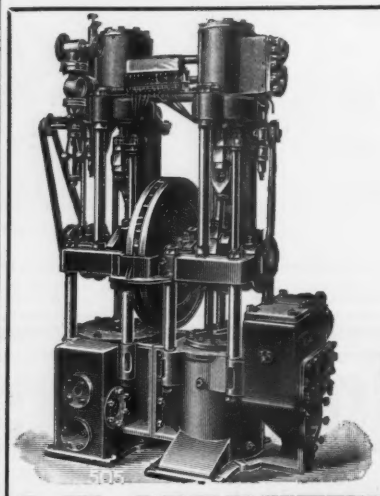

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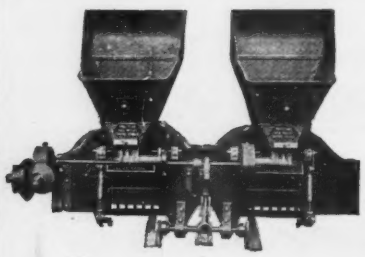

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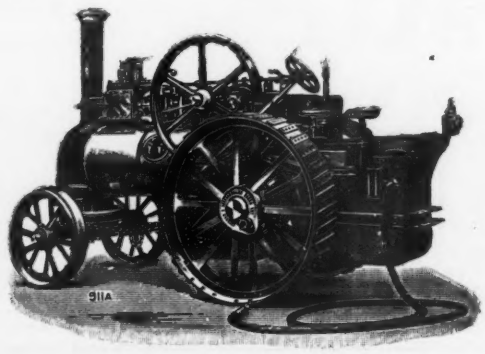

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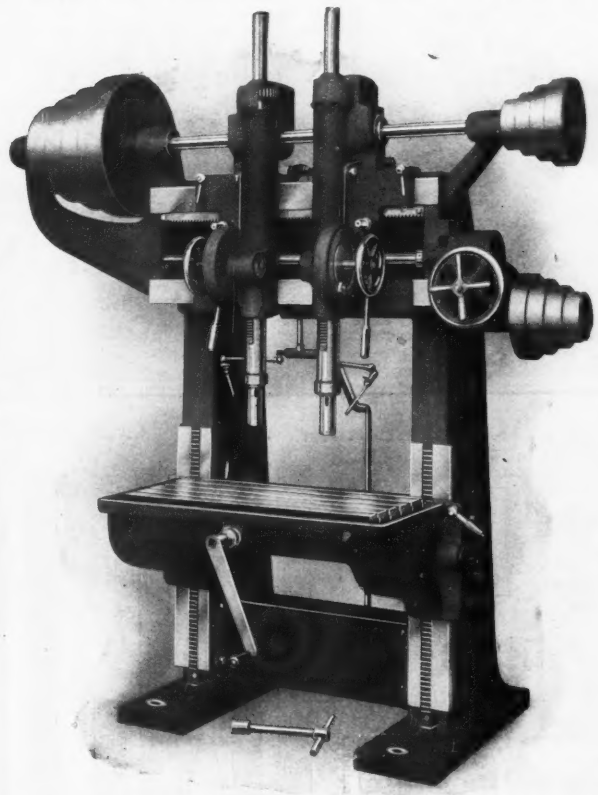

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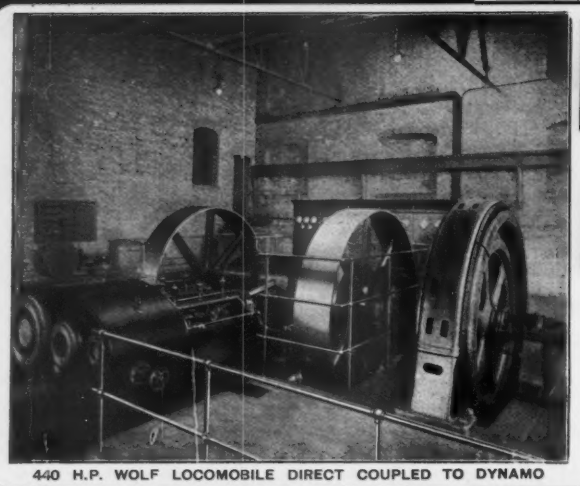

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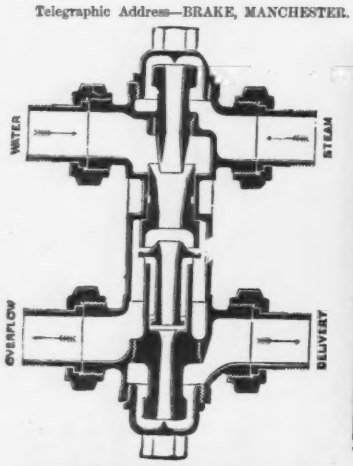

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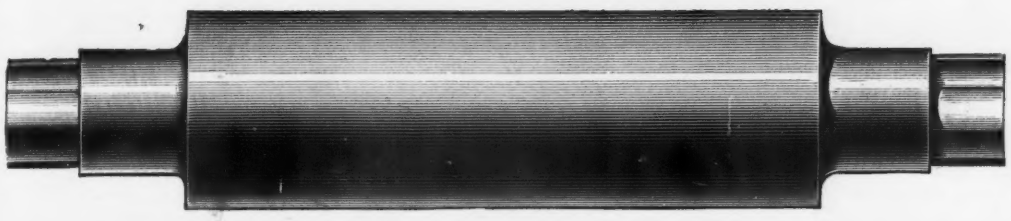

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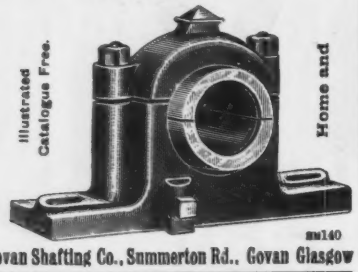

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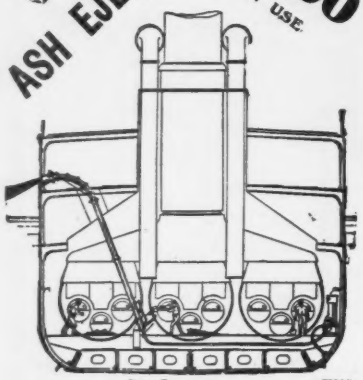

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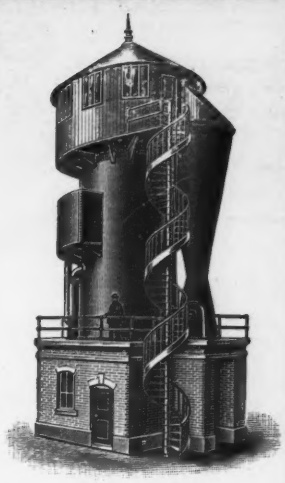

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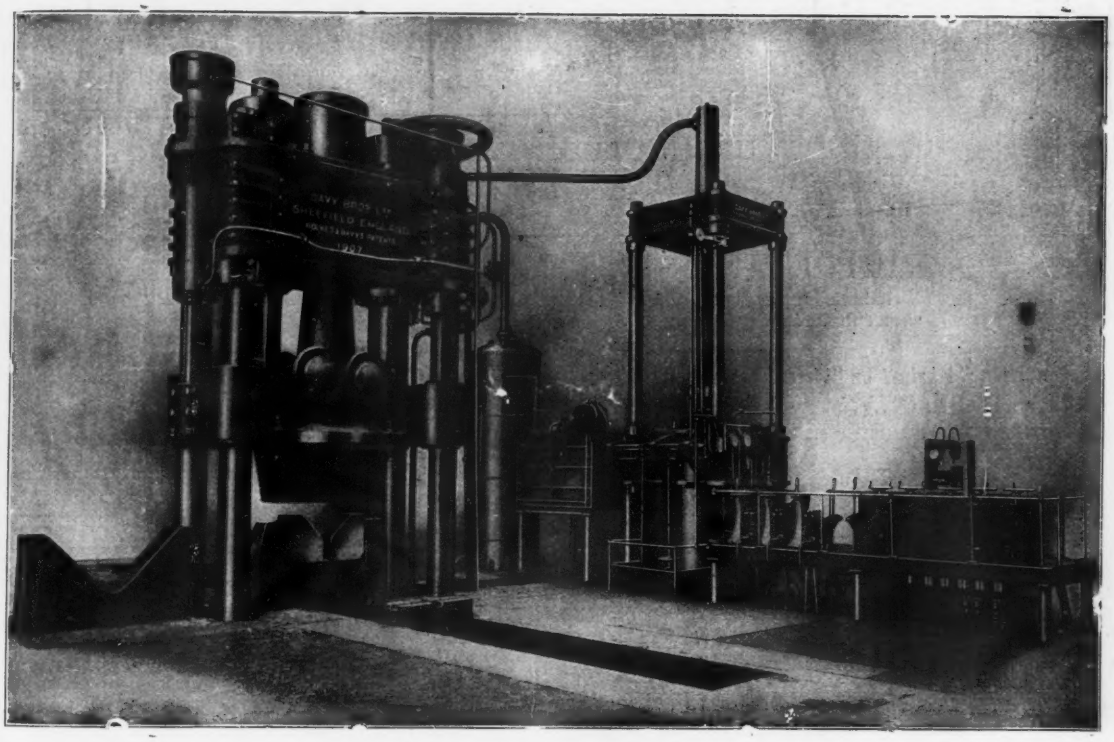

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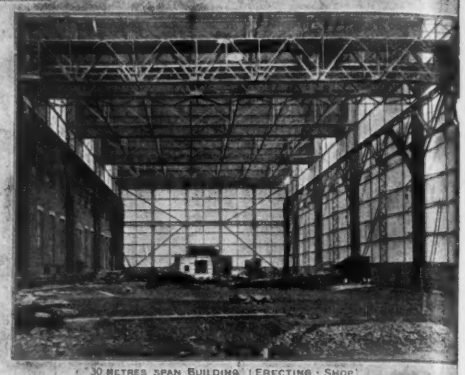

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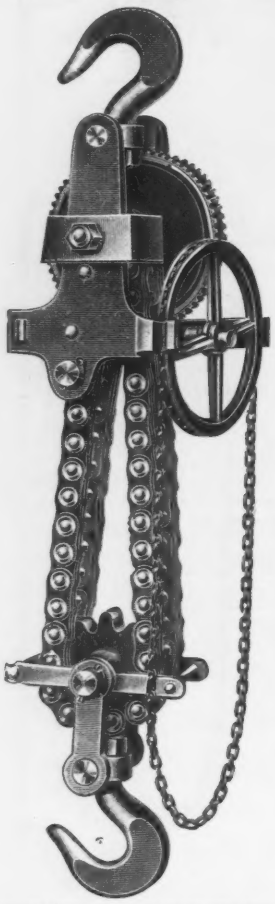

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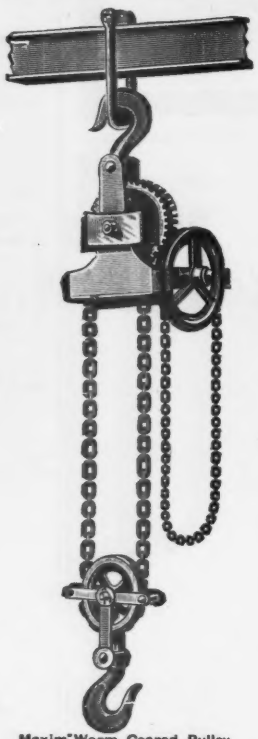

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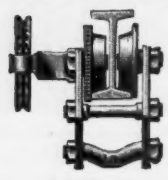

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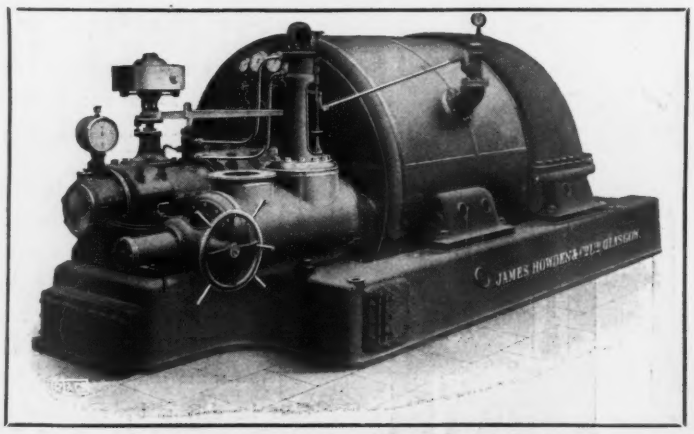

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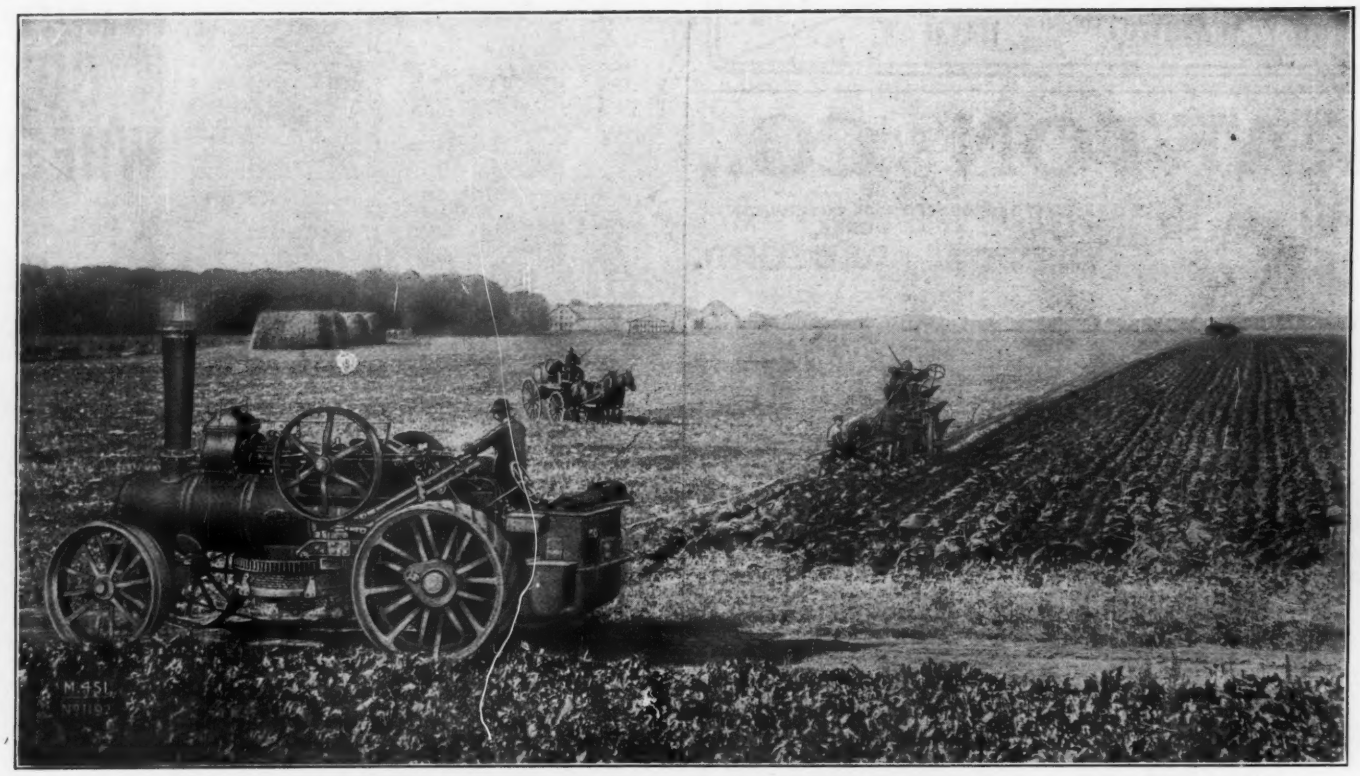

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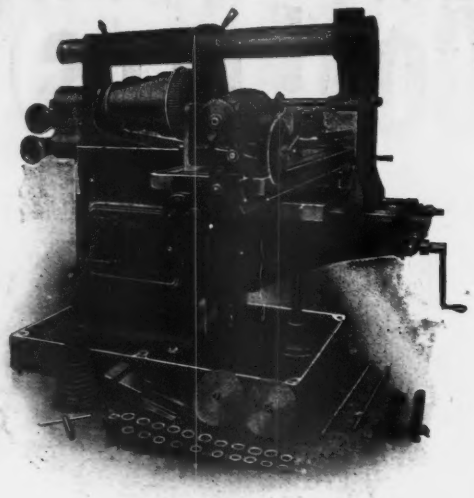

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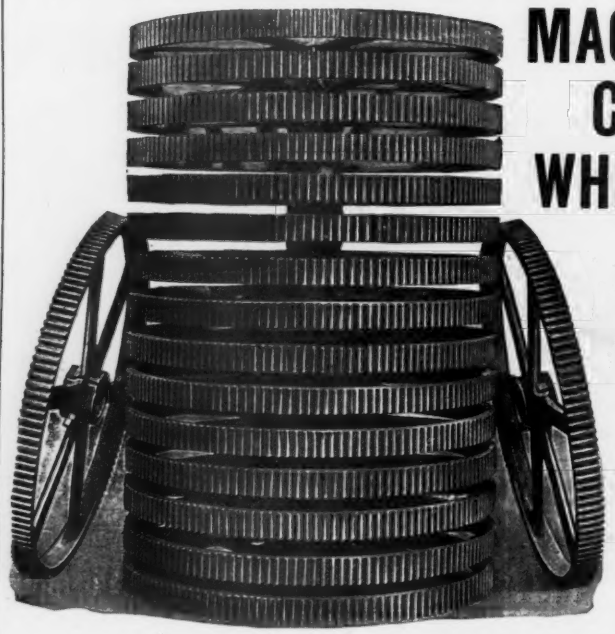

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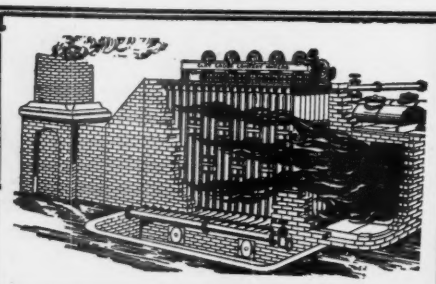

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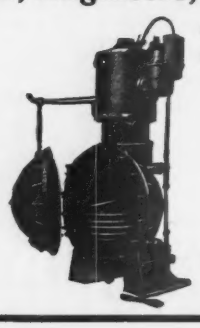

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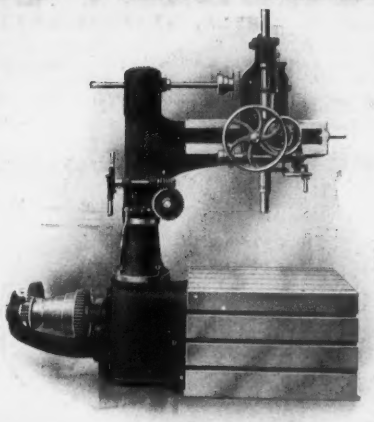

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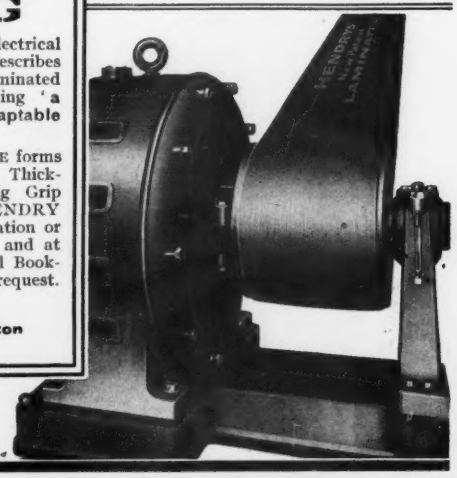

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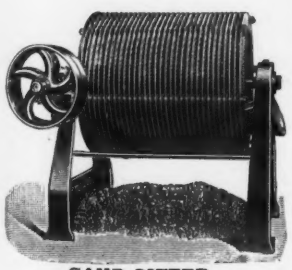

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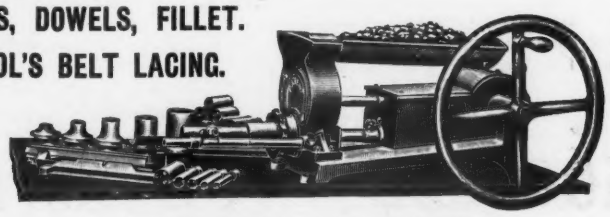

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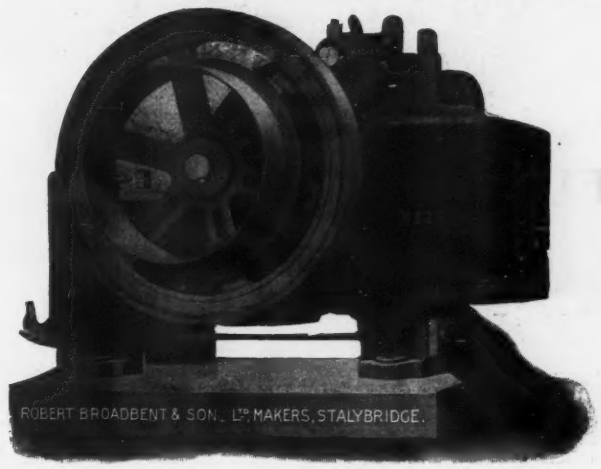

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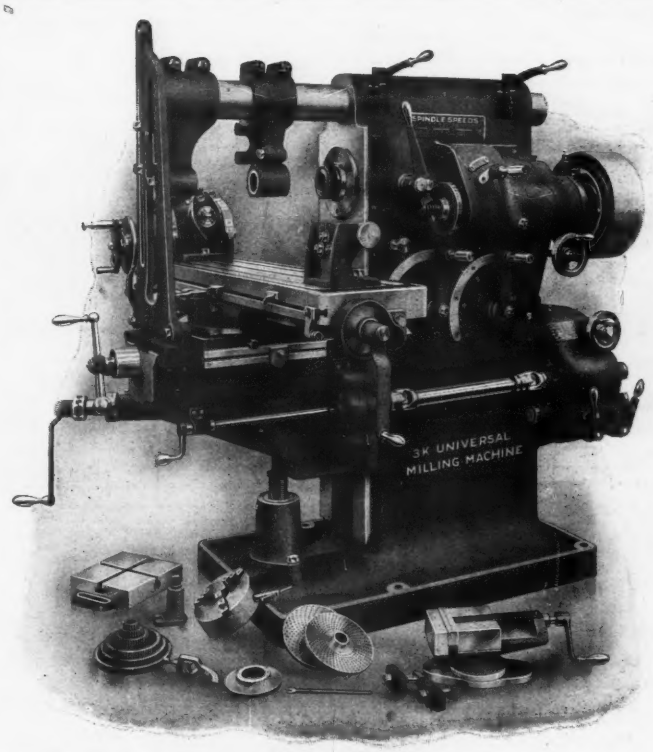

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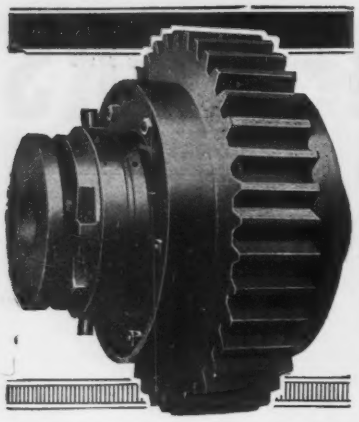

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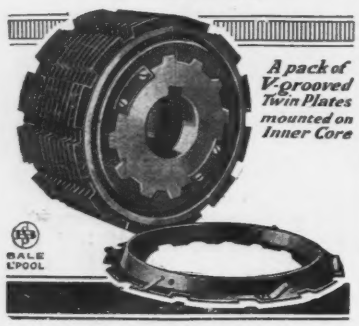

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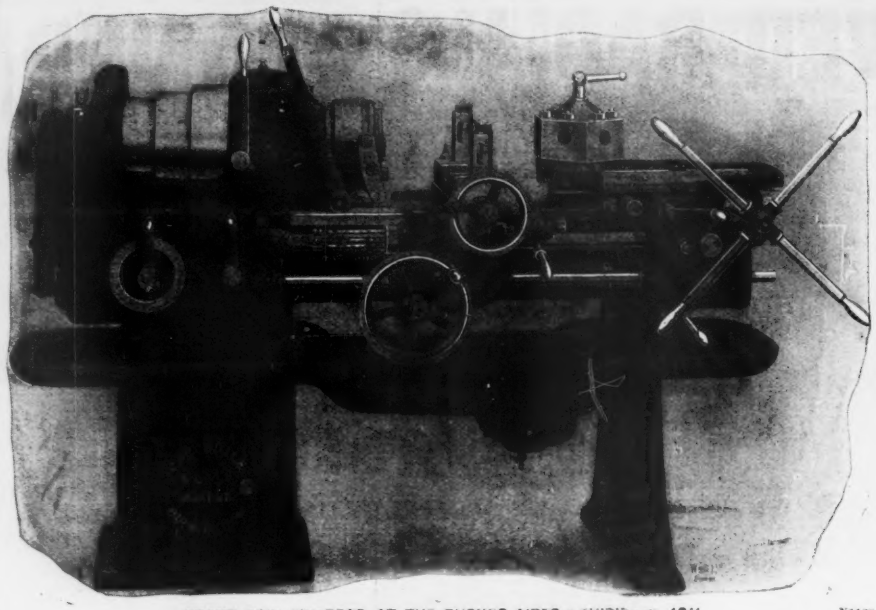

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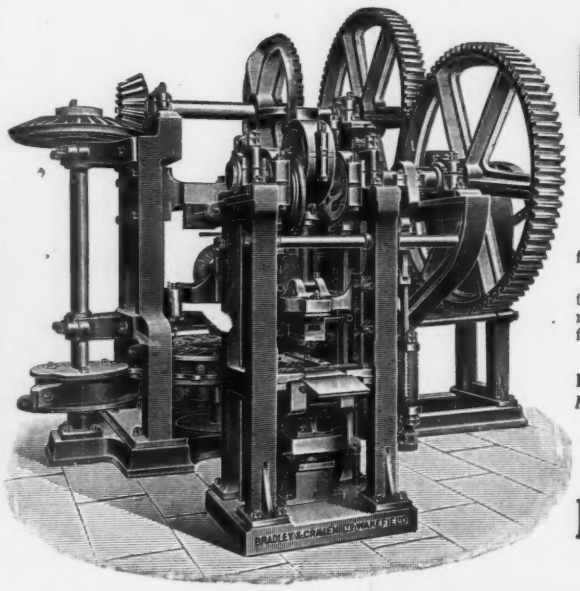

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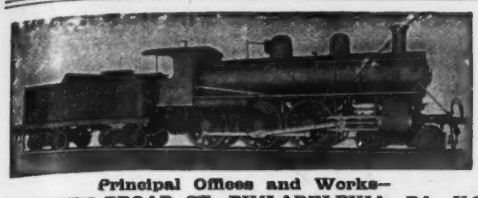

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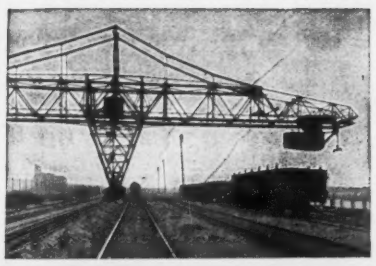

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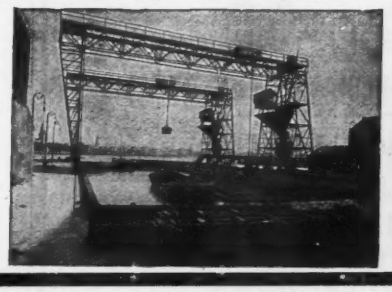

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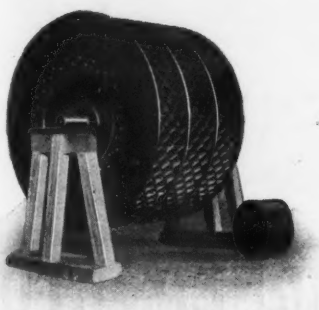

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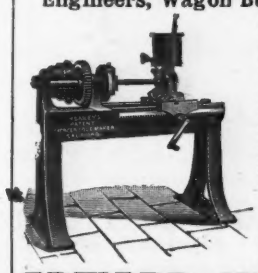

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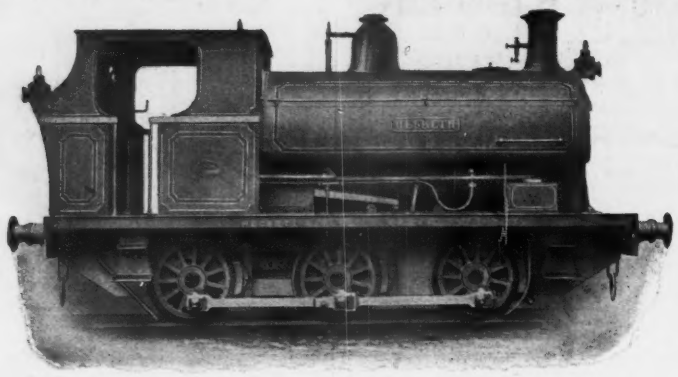

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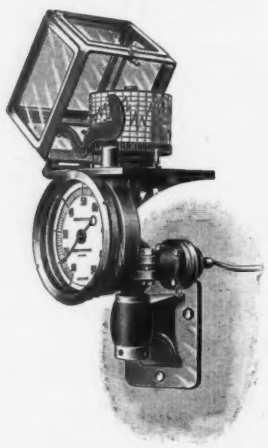

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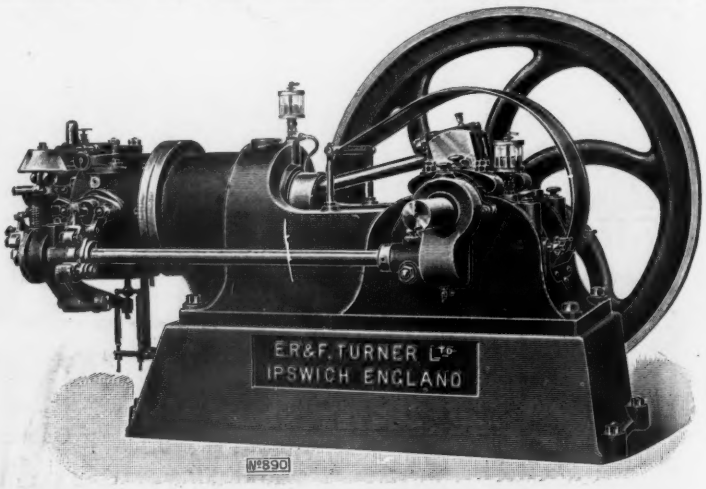

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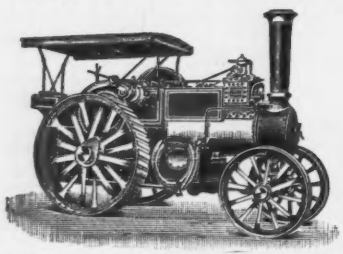

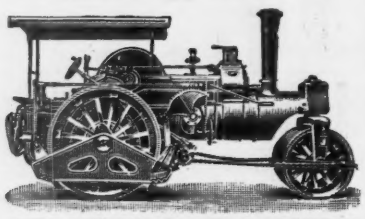

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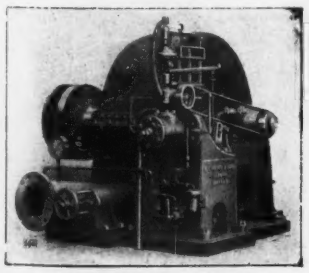

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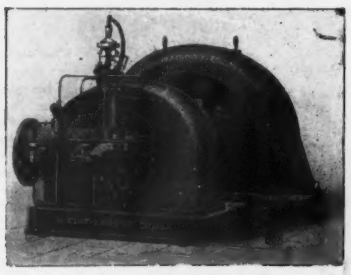

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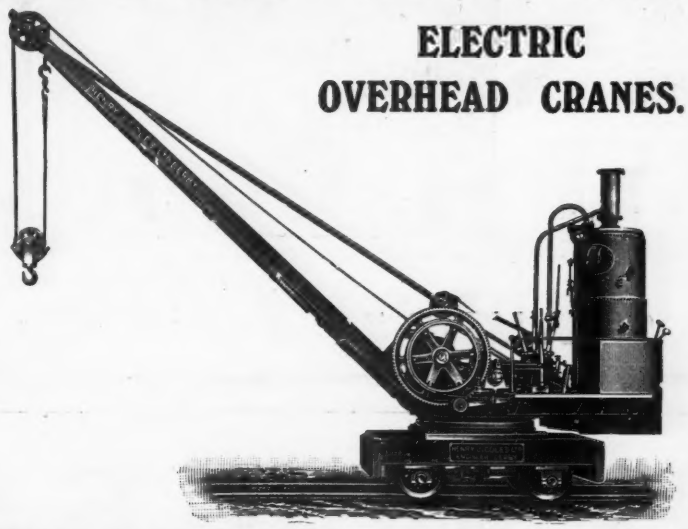

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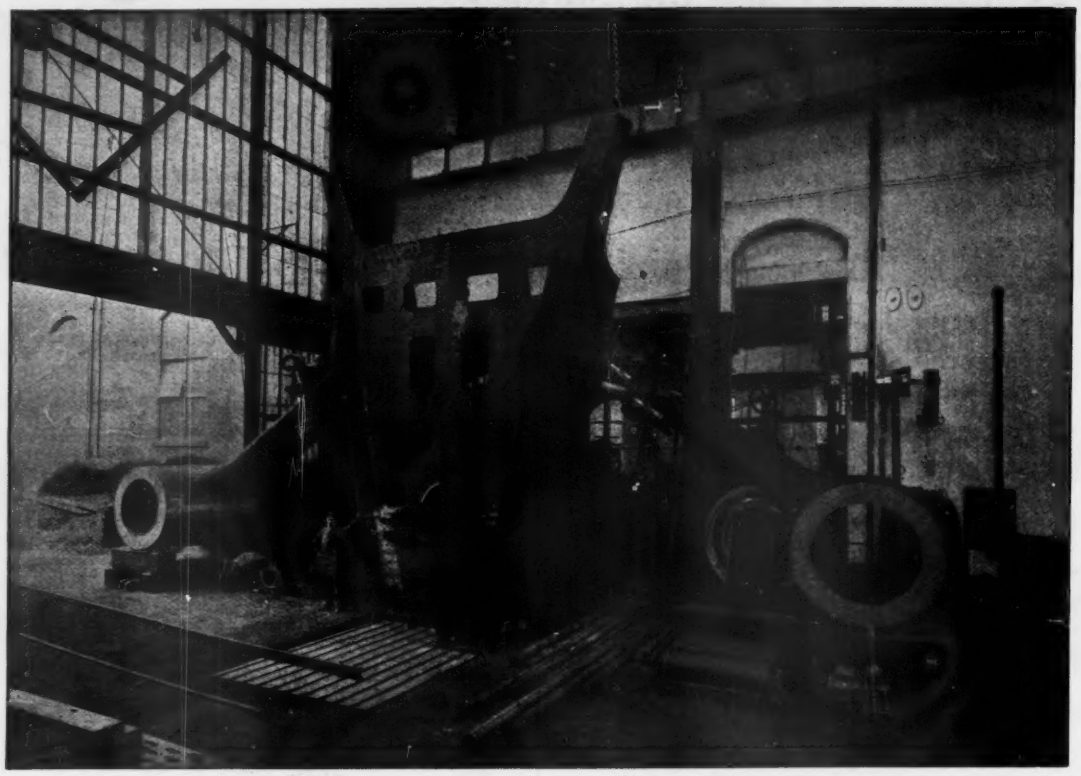

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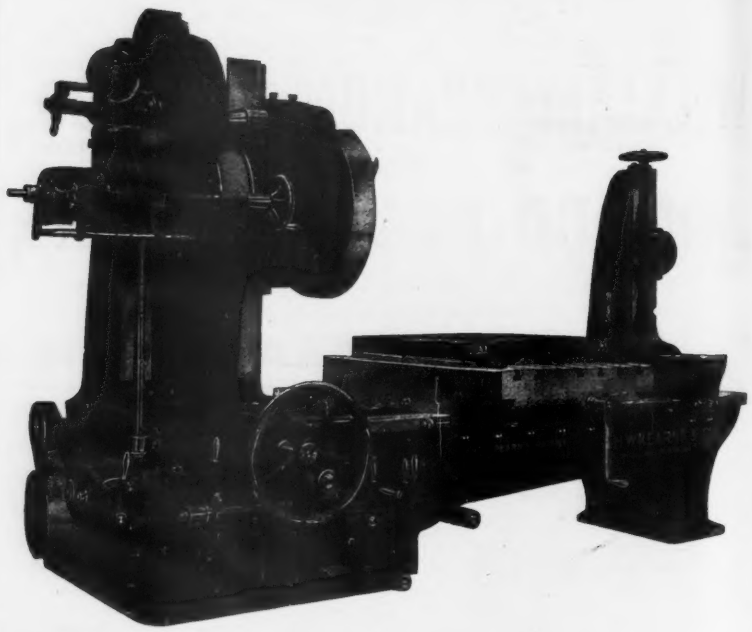

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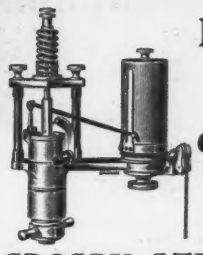

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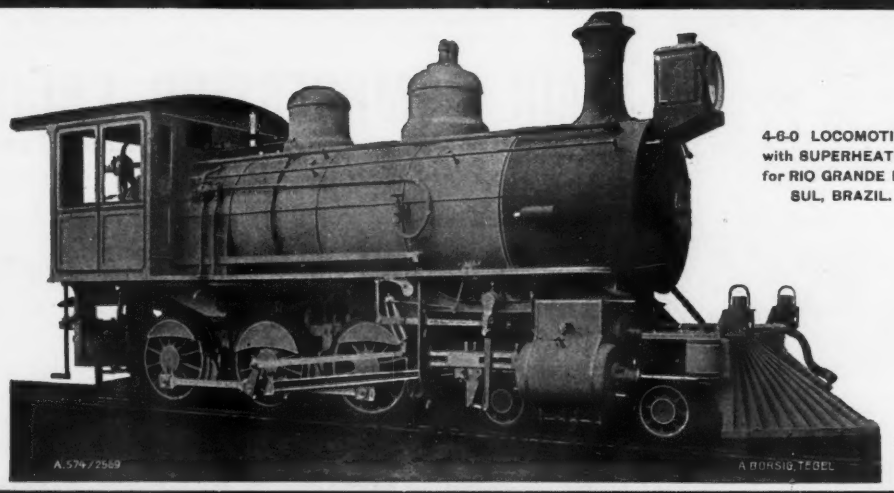

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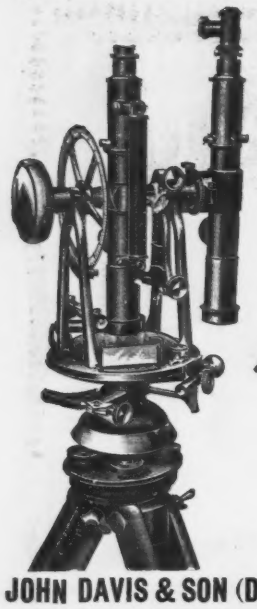

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D362
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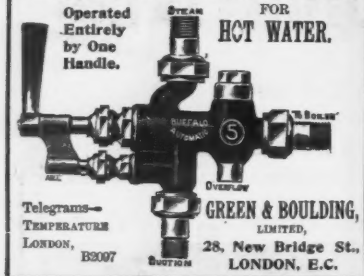

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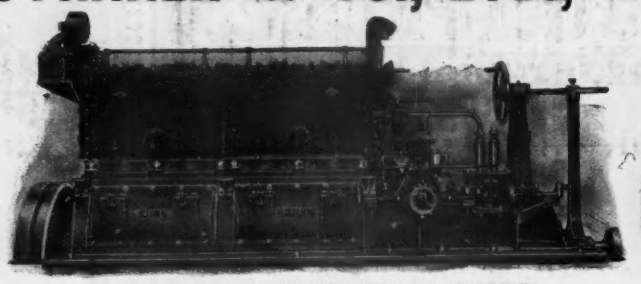

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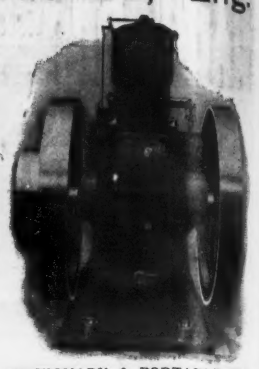

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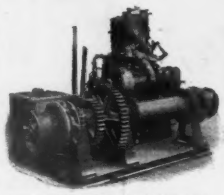

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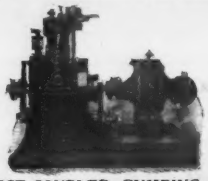

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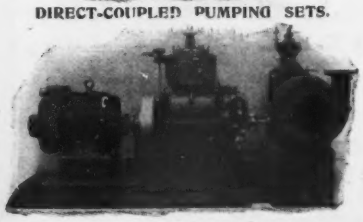

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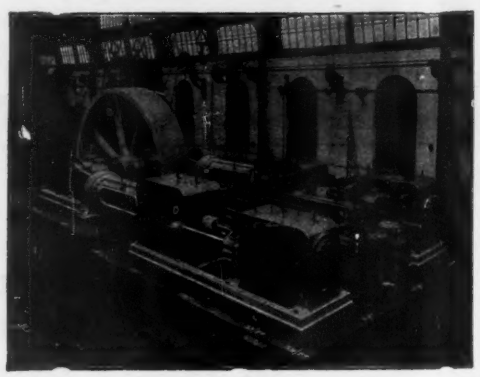

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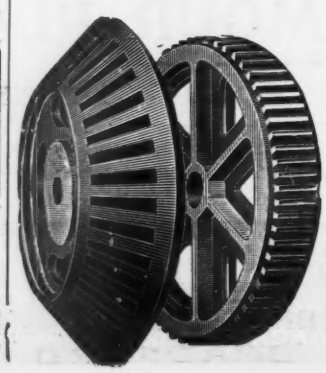

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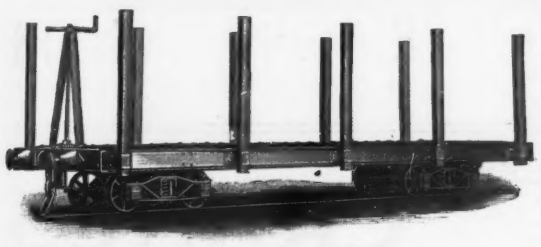

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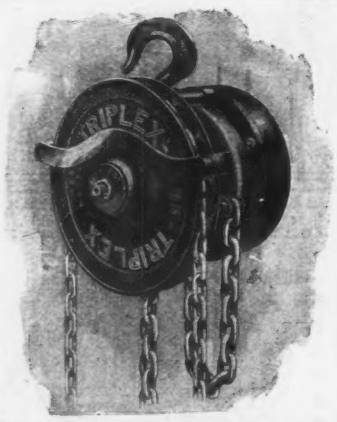

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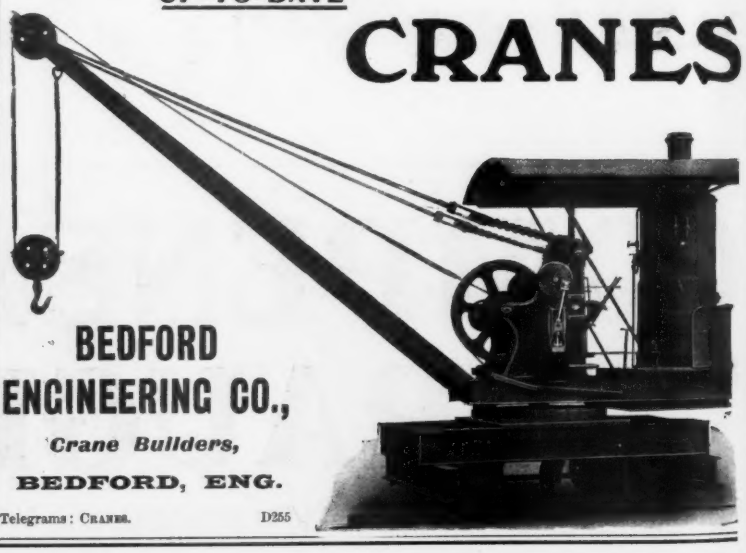

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BEDFORD, ENG.

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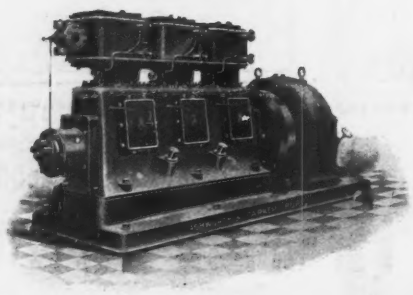

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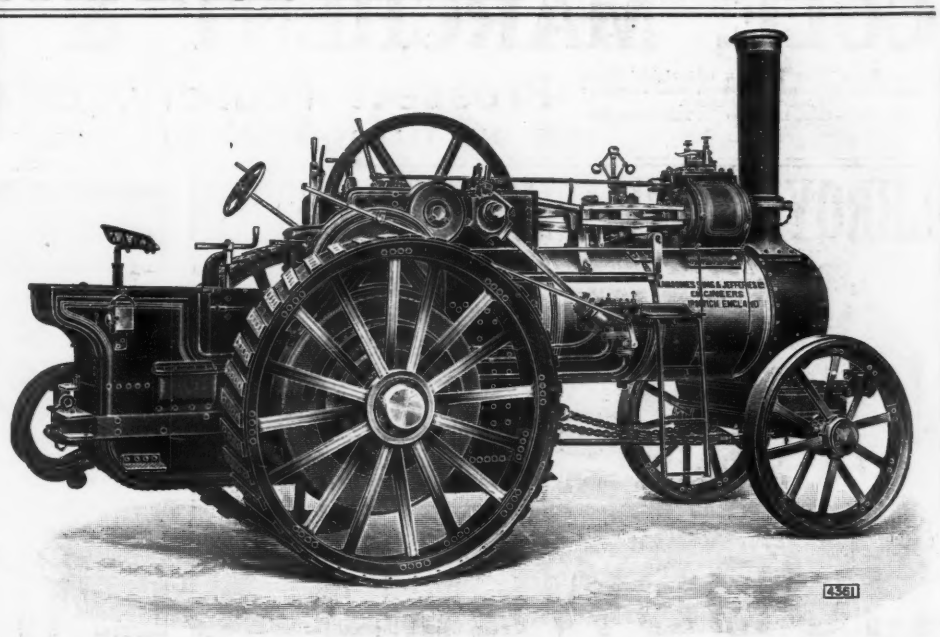

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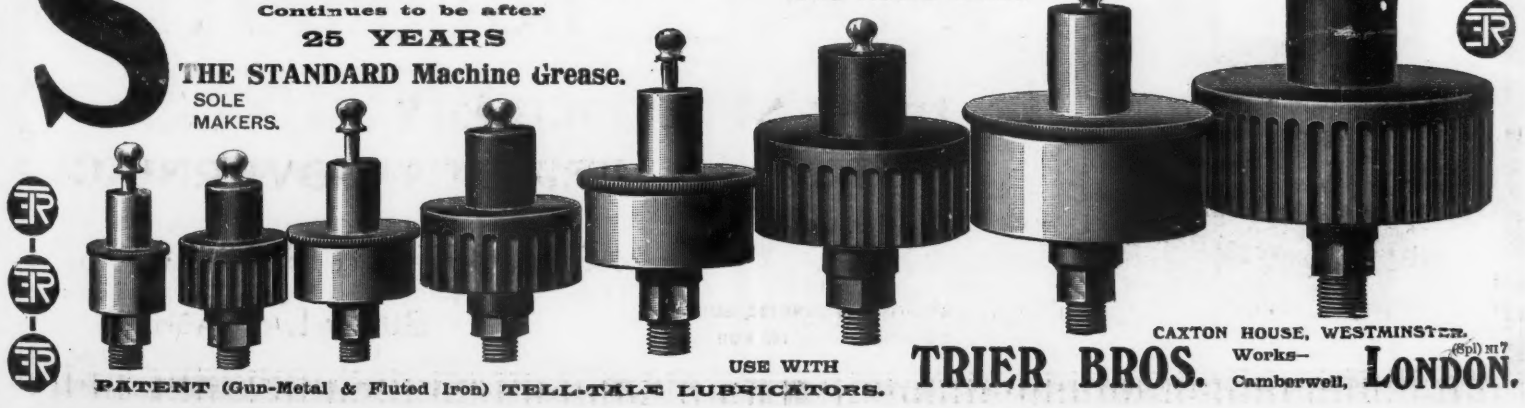

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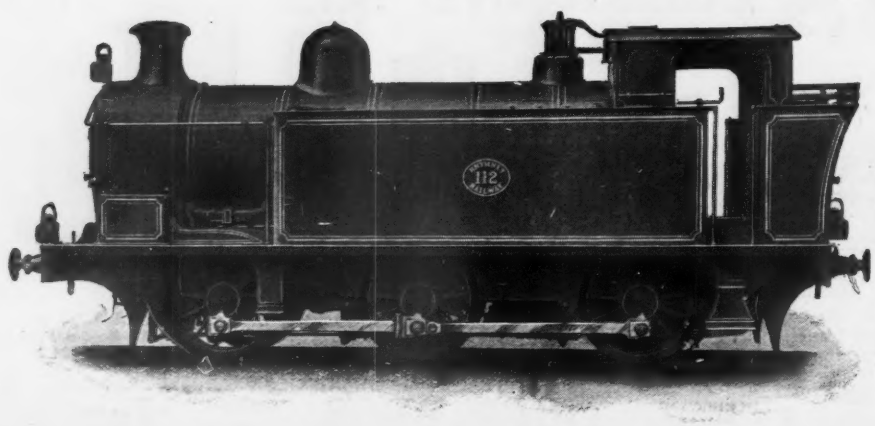

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Zobel, Neubert and Co

Cupolas
Davies, T., and Son

Destructors
Horsfall Destructor Co., Ld

Diving Apparatus
Barnett and Foster
Siebe, Gorman and Co., Ld

Dog Spikes
Clyde Nail Co., Ld

Drawing Apparatus
Davis, J., and Son, Ld

Drawings and Tracings
Thorp, J. B.

Dredge Plant
Ferguson Brothers
Fleming and Ferguson, Ld
Gwynnes Limited
Lobnitz and Co., Ld
Priestman Bros., Ld
Simons, W., and Co., Ld
Smulders, A. F.

Drop Forgings and Stampings
Armstrong, Stevens and Son
Horton and Son, Ld

Drop Hammers
Brett's Patent Lifter Co., Ld
Ross, R. G., and Son, Ld

Dynamometers
Heenan and Froude, Ld

Electricity
Brit. Westinghouse Electric Co
Crompton and Co., Ld
Dick, Kerr and Co., Ld
Electromotors Ld
English Electrical Co., Ld
Ferranti Limited
Fowler, J., and Co., Ld
Hall J. P., and Co
Hartnell, W., and Co., Ld
India-rubber, Gutta-percha, & Telegraph Works Co., Ld
Laurence, Scott and Co., Ld
Leitner Electrical Co
Phillips, J. W. and C. J.

Electricity (*cont.*)
Phœnix Dynamo Co., Ld
Rees Roturbo Mfg. Co., Ld
Reyrolle and Co., Ld
Siemens Bros. Dynamo Works

Electric Welding
British Insulated and Helsby Cables, Ld

Elevators
Bagshawe and Co., Ld
Chain Belt Engineering Co
Conveyor and Elevator Co
East Ferry Road Eng'g Co
Leech, Goodall and Co

Emery, Emery Wheels, &c.
Carborundum Co
Davies, W. J., and Sons
London Emery Works Co
Luke and Spencer, Ld
Mayer and Schmidt
Mitchell's Emery Wheel Co
Oakey, J., and Sons
Sterne, L., and Co., Ld

Engine & Boiler Fittings, &c.
Bell's United Asbestos Co., Ld
Hopkinson, J., and Co., Ld
Hulburd Engineering Co
Klinger, R., and Co
Schaffer and Budenberg, Ld

Engineers' Studs
Beebee, A.

Evaporators
Blair, Campbell and McLean
Davie and Horne
Liverpool Engineering and Condenser Co., Ld

Excavators
Priestman Bros., Ld
Wilson, J. H., and Co., Ld

Explosives
Curtis's & Harvey, Ld

Fans & Turbines
Allen, W. H., Son and Co., Ld
Boving, J. Orten, and Co
Buffalo Forge Co
Hunsted and Chandler, Ld
Davidson and Co., Ld
Gibbs, John, and Sons
Gilkes, G., and Co., Ld
Gunther, W., and Sons
Keith and Blackman Co., Ld
Parsons, C. A., and Co
Pitman, Percy
Russell, S., and Sons
Thwaites Brothers, Ld
Waddle Patent Fan and Engineering Co

Feed-water Heaters
Caird and Rayner
Davie and Horne
Holden and Brooke, Ld
Royles Limited
Weir, G. and J., Ld
Wheeler Condenser and Engineering Co
Wright, Jos., and Co

Filters, Waste Oil
Wells, A. C., and Co

Flour Mill Engineers
Turner, E. R. and F.

Forced Draught
Howden, J., and Co
Sturtevant Engineering Co

Forgings
Brown, J., and Co., Ld
Cammell, Laird and Co., Ld
Darlington Forge Co., Ld
Firth, T., and Sons, Ld
Grantham Boiler and Crank Co
Ince Forge Co., Ld
Mills, Exors. of J.
Rotherham Forge Co., Ld
Walker Bros., Ld., Wigan

Friction Clutches
Bagshaw, J., and Sons, Ld
British Helsby-Shaw Clutch Co
Coil Clutch Co., Ld
Edmeston, A., and Sons, Ld
Efandem Co., Ld
Kay, J. C., and Co., Ld
Saver Clutch Co., Ld
Unbreakable Pulley and Mill Gearing Co., Ld
Wigglesworth, F., and Co., Ld

Fuel Economisers
Clay Cross Co
Green, E., and Son
Schulz, M. R., Ld

Furnace Bars
Miller and Co., Ld

Furnaces
Burdon, J., and Sons
Dowson and Mason Gas Plant Co., Ld
Fraser and Chalmers, Ld
Leeds Forge Co., Ld
Meldrum Bros., Ld

Fusible Plugs
Bailey, W. H., and Co., Ld
National Boiler and General Insurance Co

Galvanising Plant
Butterfield, W. F., Ld
Lysaght, J., Ld

Gas
British Hydrogen Co
Dowson & Mason Gas Plant Co
Power Gas Corporation, Ld

Gas Compressors
Belliss and Morcom, Ld

Gas Engines
Anderston Founory Co., Ld
British Westinghouse Electric and Manufacturing Co., Ld
Crossley Brothers, Ld
Davey, Paxman and Co., Ld
Dudbridge Ironworks, Ld
Fielding and Platt, Ld
Gardner, L., and Sons, Ld
Grice's Gas Engine Co., Ld
Hindley, E. S., and Sons
Hornsby, R., and Sons, Ld
Keighley Gas & Oil Engine Co
Kynoch Ld
Mather and Platt, Ld
National Gas Engine Co., Ld
Premier Gas Engine Co., Ld
Ruston, Proctor and Co., Ld
Shardlow, A., and Co., Ld
Tangyes Limited

Gauge Glasses
Butterworth Bros., Ld
Guilbert-Martin
Hopkinson, J., and Co., Ld
Moncrieff, J., Ld
Tomey, J., and Sons, Ld

Gauge Glass Protectors
Hulburd Engineering Co
Tomey and Sons, Ld

Gauges
Crosby Steam Gage & Valve Co
Crown Works, Chelmsford
Klinger, R., and Co
Negretti and Zambra
Newall Engineering Co
Schaffer and Budenberg, Ld
Tomey and Sons, Ld

Gear Cutting
Barlow and Chidlaw Ld
Brown, D., and Sons, Ld
Northern Manufact'g Co., Ld

Gearing
Bliss Co., E. W.
Bodley Brothers and Co
Brown, D., and Sons, Ld
Citroem, A., and Co
Harpers Limited
Reid Gear Co
Unbreakable Pulley Co., Ld
Wigglesworth, F., and Co

Governors
Monovel Governor Co
Pollock, Macnaband Highgate

Grinding Machinery
Bradley Pulveriser Co
Mayer and Schmidt
Mitchell's Emery Wheel Co
Smedley Bros., Ld

Grindst'ne Dressers and Safety Rests
Brunton and Trier

Hammers
Davis and Primrose
Dunlop, J.
Massey, B. and S.
Player, W. and J.
Pollock, Macnaband Highgate
Ross, R. G., and Son
Samuelson and Co., Ld
Thwaites Brothers, Ld

Handles
Burley and Son, Ld

Harbour Plant
Stothert an i Pitt, Ld
Wilson, John H., and Co., Ld

Haulage Gear
East Ferry Road Eng'g Co
Grant, Ritchie and Co

Heating Apparatus
Browning, W. E., and Co., Ld
Körting Brothers, Ld

Hose
Merrywether and Sons, Ld
Reddaway, F., and Co., Ld

Hydraulic Machinery
Arrol, Sir W., and Co., Ld
Berry, H., and Co., Ld
Fielding and Platt, Ld
Hoit and Willetts
Musgrave Bros.
Rice and Co., Ld
Shaw, John, and Sons, Ld
Smith Bros. and Co., Ld
Smith, Hugh, and Co
Stewart, D., and Co., Ld
Vacher, H. P.
Youngs

Hydro-extractors
Broadbent, T., and Sons, Ld

Ice Machinery (*see* Refrigerating Mach'y)

Igniter, Gas and Oil Engine
Lodge Bros. and Co

India-rubber, &c.
Contin'tal Tyre & Rubber Co
Dunlop Rubber Co., Ld
India-rubber, Gutta-percha, & Telegraph Works Co., Ld
Reddaway, F., and Co., Ld

Injectors & Ejectors
Davies and Metcalfe, Ld
Green and Boulding, Ld
Gresham and Craven, Ld
Holden and Brooke, Ld
Klinger, R., and Co
Wilcox, W. H., and Co., Ld

Insurance
Sun Insurance Office

Iron and Steel Works Plant
Brown, J., and Co., Ld
Davy Bros., Ld
Dewhurst Engineer'g Co., Ld
Jones, George, Ld
Stevensons, Preston

Iron and Steel Buildings & Roofs
Ash, J., and Son
Bagshaw, J., and Sons, Ld
Bennis, E., and Co., Ld
Boulton and Paul, Ld
Braby, F., and Co
Brownlie and Murray, Ld
Bruce and Still, Ld
Clayton, Son and Co., Ld
Cleveland Bridge & Eng'g Co
Clyde Structural Iron Co., Ld
Grover and Co., Ld
Lysaght, J., Ld
Main, A. and J., and Co
Mechan and Sons, Ld
Piggott, T., and Co., Ld
Walker Brothers, Ld

Jointing
Graphite Products, Ld
Hudson, J., and Co., Success
Jenkins Bros., Ld
Klinger, R., and Co
Walker, J., and Co

Lantern Slides
Fry, E. B.

Laundry Machinery
Summerscales Limited
Tullis, D. and J., Ld

Lead Machinery
Glover, W. T., and Co., Ld
Krupp Grusonwerk, F.,

Leatherite
Northern Rubber Co

Lifts and Hoists
Holt and Willetts
Waygood, R., and Co. Ld
Youngs

Light
Carbic Limited
Continental-Light Frankfort
U.K. Lighting Trust, Ld
Ulmann and Co., Ld
Wakefield, C. C., and Co
Wells, A. C., and Co

Locks
Kaye, J., and Sons, Ld

Locomotives
American Locomotive Co
Avonside Engine Co., Ld
Bagnall, W. G., Ld
Baldwin Locomotive Works
Beyer, Peacock and Co., Ld
Borsig, A.
British Humboldt Eng. Co
Green, T., & Sons, Ld
Hawthorn, Leslie and Co., Ld
Hudswell, Clarke and Co
Hunslet Engine Co., Ld
Kerr, Stuart and Co., Ld
North British Loco. Co., Ld
Peckett and Sons
Société Anonyme de Saint Léonard
Stephenson, R., and Co., Ld
Vulcan Locomotive Works
Wolf, R.

Lubricators
Steam Cylinder Lubricator Co
Trier Bros.
Wakefield, C. C., and Co

Machine Tools
Archdale, J., and Co
Asquith, W., Ld
Berry, F., and Sons, Ld
Berry, H., and Co., Ld
Birch, G., and Co
Britannia Engin'ring Co., Ld
Buck and Hickman Ld

Machine Tools (*con.*)
Buckton, J., and Co., Ld
Burton, Griffiths and Co
Butler, J., and Co
Cameron, J., Ld
Carron Company
Carter and Wright
Chambers, Scott and Co
Clifton and Baird
Clifton and Waddell
Craig and Donald, Ld
Craven Bros., Ld
Cunliffe and Croom, Ld
Daniell, S. A., Ld
Darling and Sellers, Ld
Davis and Primrose
Dean, Smith and Grace, Ld
Dempster, Moore and Co., Ld
Dickinson Machine Tool Co
Dron and Lawson, Ld
Drummond Bros., Ld
Goodchild, G. W., & Partner
Harvey G. and A.
Heap, J., and Co., Ld
Herbert, A., Ld
Hetherington, J., & Sons, Ld
Hill, Isaac, and Son
Hulse and Co., Ld
Greenwood and Batley, Ld
Judson-Jackson Company
Jones and Lamson Machine Co
Jones, Shipman & Pollard, Ld
Kearns, H. W., and Co., Ld
Kendall and Gent, Ld
Lang, J., and Sons
Lodge & Shipley M'e. Tool Co
Maclellan, P. and W., Ld
McGown, Rogers, and Co
McKendrick, W. D., and Co
Midgley and Sutcliffe
Muir, W., and Co
Noble and Lund, Ld
Parkinson, J., and Son
Pearn, F., and Co., Ld
Pfeil and Co
Platt, S., Ld
Pollock and McNab, Ld
Redman, C., and Sons
Reinecker, J. E.
Rice and Co., Ld
Richards, G., and Co
Ryder, T., and Son
Schuchardt and Schutte
Scott Bros
Selson Engineering Co., Ld
Shanks, T., and Co
Smith and Coventry, Ld
Smith Bros. and Co., Ld
Smith, G. F., Ld
Smith, Hugh, and Co., Ld
Spencer, J., and Co
Stirk, J., and Sons, Ld
Tangyes Limited
Tullis, D. and J., Ld.
U.S. Metallic Packing Co., Ld
Vickers Limited
Ward, H. W., and Co
Ward, T. W., Ld
Webster and Bennett, Ld
Wilkinson, G., and Sons

Machine Work
Chesney Engineering Co., Ld
Hooker, Peter, Ld
Rosser and Russell, Ld
Wailes, G. and Co

Malleable Castings
Ley's Malleable Castings Co

Manganese Steel Castings & Forg'gs
Cammell Laird and Co., Ld
Firth, T., and Sons, Ld
Hadfield's Steel Foundry Co

Manholes
M'Neil, C.
Rolled Steel Forge Co., Ld

Marine Machinery
Broadfoot, J., and Sons, Ld

Mathematical Instruments
Negretti and Zambra
Stanley, W. F., and Co., Ld

Measur'g Machines
Newall Engineering Co

Merchant Iron
Dunkerley, C. C., and Co., Ld
Farnley Iron Co., Ld
Henderson and Glass

Metals
Atlas Metal and Alloys Co., Ld
Bull's Metal & Melloid Co., Ld
Delta Metal Co., Ld
Electric and Ordnance Accessories Co., Ld
Johnson, Clapham and Morris
Magnolia Anti-Friction Metal Co. of Great Britain, Ld
Phosphor Bronze Co., Ld
Tandem Smelting Syndicate

Meters
British Thomson-Houston Co
Glenfield and Kennedy Ld
Lea Recorder Co

Mica
Wiggins, F., and Sons

Mining Machinery
Chesters Renfrew Eng'ing Co
Davey, Paxman and Co., Ld
Krupp Grusonwerk, F.
Ransomes, Sims and Jefferies
Robey and Co., Ld
Sandycroft Foundry Co., Ld
Walker Brothers, Wigan

Motors
Bergius Launch & Engine Co
Electromotors Ld
Parsons Motor Co., Ld
Phœnix Dynamo Mfg. Co., Ld

Motor Cars
Clement Talbot, Ld
Drewry Car Co., Ld
Mann's Patent Wagon Co
Thornycroft, J. I., and Co. Ld

Moulding Machines
Greenwood and Batley, Ld
London Emery Works Co
Samuelson and Co., Ld

Oil Engines
Blackstone and Co., Ld
Britannia Engineering Co
Crossley Brothers, Ld
Diesel Engine Co., Ld
Dudbridge Ironworks, Ld
Fielding and Platt, Ld
Gardner, L., and Sons
Hornsby and Sons, Ld
Keighley Gas & Oil Engine Co
Mirrlees, Bickerton & Day, Ld
Normand, A., Ld
Petters Ld
Reavell and Co., Ld
Sharer and Young, Ld
Wilson, A.
Wilson, C. F., and Co

Oil Pumps
British Manzel Oil Pump Co

Oil Separators
Baker Oil Separator Co., Ld
Balcke and Co., Ld
Harvey, Telford and Hardman
Holden and Brooke, Ld
Kater and Ankersmit
Paterson Engineering Co., Ld

Oil-gas Apparatus
Mansfield and Sons, Ld

Oil Mill Machinery
Rose, Downs & Thompson, Ld

Oils & Lubricants
Price's Patent Candle Co
Trier Brothers
Stern Sonneborn Oil Co., Ld
Wakefield, C. C., and Co

Oil Well Drills
Oil Well Supply Co

Overhead Runways
Vaughan and Son, Ld

Oxygen
British Oxygen Co., Ld
Knowles Oxygen Co., Ld

Packing, Metallic
Green and Boulding, Ld
Greene, Tweed and Co
Hobdell, Way and Co., Ld
Hudson, J., & Co., Successors
Hulburd Engineering Co
Klinger, R., and Co
Lancaster and Tonge, Ld
U.E. Metallic Packing Synd
U.S. Metallic Packing Co., Ld
Walker, J., and Co

Painting Machines
Wells, A. C., and Co

Patent Agents
Alexander, E. P., and Son
Harris and Mills
Jensen and Son
Lloyd Wise and Co
Redfern, G. F., and Co
Roots, J. D.
Vaughan and Son
Withers, J. S., and Spooner

Pattern Makers
Brown, D., and Sons, Ld

Pattern Making Machinery
Wadkin and Co

Perforated Metals
Barns. W. and Son

Photo Printing
Halden, J., and Co., Ld
Hall, R. J., and Co., Ld

Pig Iron
Clay Cross Co
Lilleshall Co

Pipes, Iron & Steel
Ashmore Benson Pease & Co
Boving, J. Orten, and Co
British Welding Co., Ld
Dempster, R. and J.
Mechan and Sons
Metal & Machinery Syndicate
Piggott, T., and Co., Ld
Stewarts and Lloyds, Ld

Pistons
Lancaster and Tonge, Ld
Lockwood and Carlisle, Ld
M'Neil, C., jun.
Standard Piston Ring Co., Ld

Plates, Steel
Colville, D., and Sons, Ld
Glasgow Iron and Steel Co

Plummer Blocks
Jardine, J.
Unbreakable Pulley Co., Ld
Wigglesworth, F., and Co., Ld

Pneumatic Tools
Consolidated Pneumatic Tool Co., Ld
Globe Pneumatic Eng. Co., Ld

Portland Cement
Wouldham Cement Co., Ld

Printing
Garnett, H., and Co., Ld
Reveirs, Geo., Ld

Presses
Berry, H., and Co., Ld
Brett's Patent Lifter Co., Ld
Fawcett, Preston and Co., Ld
Hands, J., and Sons, Ld
Taylor and Challen, Ls

Pulley Blocks
Bullivant and Co., Ld
Godfrey, J. T.
Mork Patent Pulley Block Co
Vaughan and Son. Ld
Ya'e and Towne Mfg. Co

Pulleys
Douglas, Lawson and Co
Fraser, Douglas, & Sons, Ld
Harpers Limited
Hudswell, Clarke and Co., Ld
Mork Patent Pulley Block Co
Smith and Grace
Thompson and Southwick, Ld
Unbreakable Pulley Co., Ld
Urquhart, Lindsay & Co., Ld

Pumps
Batchelor, Richd. D.
Brackett, F. W., and Co., Ld
Cameron, J. Ld
Carruthers, J. H., and Co
Clarke, Chapman and Co., Ld
Cochrane, John
Daniels, T. H. and J., Ld
Drum Engineering Co
Drysdale, J., and Co
Easton and Anderson
Entwisle and Gass, Ld
Evans, J., and Sons
Fleming and Ferguson, Ld
Gimson and Co., Ld
Glenfield and Kennedy, Ld
Glover and Hobson, Ld
Gwynnes, Ld
Hall, J. P., & Sons, Peterboro
Hathorn, Davey and Co., Ld
Hayward-Tyler and Co., Ld
Hughes and Lancaster
Lamplough and Son, Ld
Manlove, Alliott and Co., Ld
Merryweather and Sons, Ld
Mumford, A. G., Ld
Pearn, F., and Co., Ld
Potter, A. C., and Co
Pulsometer Engin'ing Co., Ld
Reader, E., and Sons, Ld
Rees Roturbo Mfg. Co., Ld
Richards, R., and Co
Simpson, J., and Co., Ld
Storey, I., and Sons, Ld
Tangyes Limited
Thwaites Bros., Ld
Warner, R., and Co
Weir, G. and J., Ld
Westinghouse Brake Co., Ld
Wilcox, W. H., and Co., Ld
Willans and Robinson, Ld
Worthington Pump Co., Ld

Quarrying Machinery
Sullivan Machinery Co

Railway Plant
Bagnall, W. G., Ld
Birch, J., and Co., Ld
Bolling and Lowe
Cammell Laird and Co., Ld
Cravens, Limited
Dick, Kerr and Co., Ld
Firth, T., and Sons, Ld
Fowler, J., and Co., Ld
Glasgow Rail and Engin'g Co
Griffith, W., and Sons
Harrison and Camm, Ld
Hudson R.
Isca Foundry Co
Kerr, Stuart and Co., Ld
Koppel, A.
Laycock, W. S., Ld
Leeds Forge Co., Ld
Maclellan, P. and W., Ld
McLachlai. and Co
Midland Railway Carriage Co
Motor Rail & Tramcar Co., Ld
Patent Shaft and Axletree Co
Pickering, R. Y., and Co., Ld
Railway & General Eng'g Co
Ransomes and Rapier, Ld
Stableford and Co
Summerson, T., and Sons, Ld
Turner, G. R., Ld
United Electric Car Co., Ld

Rams, Hydraulic
Bailey, W. H., and Co., Ld
Blake, John, Ld
Vacher, H. P.

Reducing Valves
Auld, D., and Son
British Steam Specialties
Royles Limited,

Refrigerating Machinery
Brit. Humboldt Eng. Co., Ld
Hall, J. and E., Ld
Haslam Foundry and Engineering Co., Ld
Linde British Refrigeration Co
Pulsometer Engineering Co
Sterne, L., and Co., Ld

Rivets
Lyall Brothers

Rock Drills
Hardy Patent Pick Co., Ld
Sullivan Machinery Co

Rolls and Rolling Mill Plant
Bayliss, Jones and Bayliss
Perry, T., and Son, Ld
Tennent, R. R., Ld

Roofs (*see* Iron Bldgs.)

Sand Blast Machinery
Tilghman's Sand Blast Co., Ld

Sandwashers
Hardy and Padmore, Ld

Screwing Tackle
Chatwin, T.
Hulse and Co., Ld
Widdowson, J. H.
Williamson, J., and Co., Ld

Sea Water Distillers
Fawcett, Preston and Co., Ld

Separators
Rapid Magnetting Mach. Co

Sewage Plant
Manlove, Alliott and Co., Ld

Shafting
Bagshaw, J., and Sons
Fraser, Douglas, and Sons
Govan Shafting Co
Harpers Limited
Mackies, Ld
Platt, S., Ld

Shearing Machines
Jones, Geo., Ld

Ship Construction
Isherwood, J. W.

Ships' Plumbing Work
Broadfoot, J., and Sons, Ld

Signalling, Power
McKenzie, Holland & Westinghouse Power Signal Co

Small Tools
Chatwin, T.
Gardner, T. J.
Vickers Limited

Soda Water Machinery
Barnett and Foster

Springs
Lion Spring Co
Salter, G., and Co

Steam Engines
Ashworth and Parker
Bellias and Morcom, Ld
Brazil, Straker and Co., Ld
Brit. Westinghouse Electric Co
Burrell, C., and Sons
Chesters Renfrew Eng'ing Co
Clayton and Shuttleworth, Ld
Cole, Marchent and Morley, Ld
Davey, Paxman and Co., Ld
Davy Bros., Ld
Drysdale and Co., Ld
Easton and Johnson, Ld
Garrett, R., and Sons, Ld
Hatley Engine Co
Hindley, E. S., and ons
Howden, J., and Co
Lees, T. and R.
Murray, Workman & Co., Ld
Plenty and Son, Ld
Reader, E., and Sons, Ld
Reavell and Co., Ld
Richardsons, Westgarth & Co
Robey and Co., Ld
Ruston, Proctor and Co., Ld
Samuelson and Co., Ld
Saxon, G., Ld
Simon, W., and Co., Ld
Turner, E. R. and F., Ld
Wilson, A.
Yates and Thom, Ld

Steam Heating for Railway Carriages
Westinghouse Brake Co., Ld

Steam Launches
Cochran and Co., Annan, Ld
Fleming and Ferguson, Ld
Lobnitz and Co., Ld
Simons, W., and Co., Ld
Simpson, Strickland and Co
Vosper and Co., Ld
Yarrow and Co., Ld

Steam Separators
Holden and Brooke, Ld
Lancaster and Tonge, Ld

Steam Traps
Bailey, W. H., and Co., Ld
Hobdell, Way and Co., Ld
Lancaster and Tonge, Ld
Royles Ld
Whiteley, Wm., & Sons, Ld

Steel
Armstrong, Whitworth and Co
Beardmore, W., and Co
Beckett, A., and Sons, Ld
Brown. Bayley's Steel Works
Colville, D., and Sons, Ld
Firth, T., and Sons, Ld
Glasgow Iron and Steel Co., Ld
Hadfield's Steel Foundry Co
Howell and Co., Ld
Jessop, W., and Sons, Ld
Rogerson, J., and Co
Seamless Steel Boat Co
Spencer, J., and Sons
Steel Company of Scotland
Stewarts and Lloyds, Ld
Turton, T., and Son
Vickers Limited

Steel Sheets
Lysaght, J., Ld

Steel Structural Work (*see* Iron and Steel Buildings)

Steering Gear
Brown Bros. and Co., Ld

Stills and Distilling Plant
Mirrlees Watson Co., Ld
Pontifex and Wood

Stokers, Mechanical, &c.
Bennis, E., and Co., Ld
Proctor, Jas.
Triumph Stoker, Ld
Underfeed Stoker Co., Ld

Stone Breakers
Baxter, W. H., Ld
British Humboldt Eng. Co
Broadbent, R., and Son, Ld
Marsden, H. R.
Mason Bros

Suction Gas Plant (*see* Gas Engines)

Sugar Machinery
Blair, Campbell and McLean
Craig, A. F., and Co., Ld
Fawcett, Preston and Co., Ld
Manlove, Alliott and Co., Ld
McNeil, J., and Co
Mirrlees Watson Co., Ld

Superheaters
Cruse Superheater Co
Garrett and Sons, Ld
McPhail and Simpson, Ld
Schmidt Superheater Co., Ld
Superheater Units Co
Tinker, Shenton and Co., Ld

Surveying Instruments
Clarkson's
Davis, J., & Son (Derby),
Stanley, W. F., and Co., Ld

Tanks
Ash, J., and Son
Braby, F., and Co., Ld
Butterfield, W. F., Ld
Clayton, Son, and Co., Ld
Newton, Chambers & Co., Ld

Taper Pins
Mills, Exors. of J
Mountford, F.

Telemotors
Brown Bros. and Co., Ld

Textile Machinery
Mather and Platt, Ld

Thermometers
Engineering Supplies, Ld
Thermo and Pressure Instruments, Ld

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